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See how B&W Lectrosonic tubing can meet your hydraulic line requirements. Just call your B&W District Sales Office or write for Bulletin T-435. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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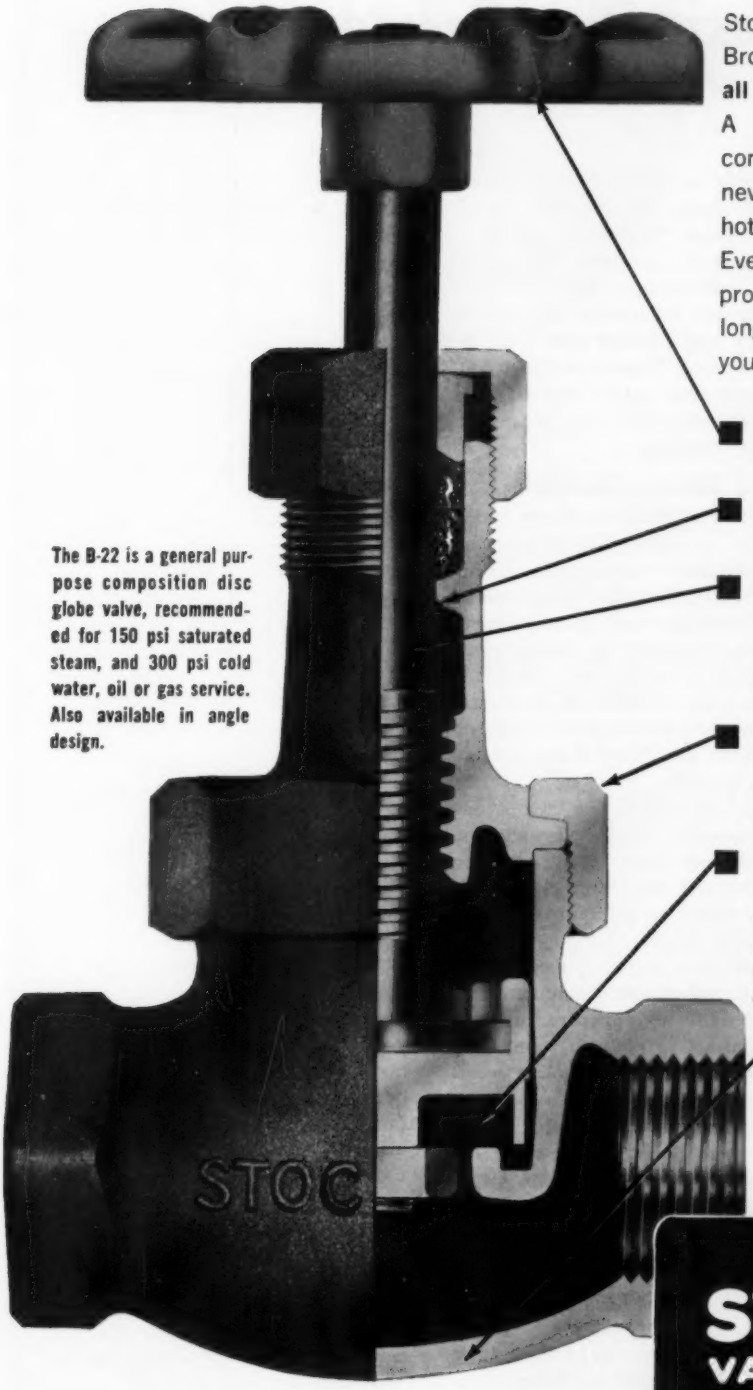

The B-22 is a general purpose composition disc globe valve, recommended for 150 psi saturated steam, and 300 psi cold water, oil or gas service. Also available in angle design.

Stockham's B-22 150 lb. Composition Disc Bronze Globe Valve puts an end **once and for all** to disc misapplications and valve failures. A unique, specially-developed, all-purpose composition disc material provides positive, never-fail control for **six services**—cold water, hot water, steam, oil, gas and compressed air. Every **other** feature of the B-22 has been proved far superior to other globe valves for long, dependable, trouble-free service. See for yourself . . .

HANDWHEEL
Easy grip, non-slip, non-heating design.

REPACKING SEAT
Can be repacked under pressure when fully open.

BESTALOY STEM
Extra large diameter for added strength. Extra length stem threads give complete engagement for longer stem life. "Bestaloy" has a minimum tensile strength of 85,000 psi.

UNION BONNET
Three-piece union bonnet design allows the valve to be reassembled easily and repeatedly without injury to body-bonnet bearing surfaces.

ALL PURPOSE COMPOSITION DISC
This one disc controls cold water, hot water, steam, oil, gas and compressed air. Slip-on type disc holder is guided throughout travel for perfect alignment.

HEAVY WALL SECTION BODY
Designed for minimum pressure drop. Extra heavy ribbed design gives maximum resistance to line strain.

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New 200 to 2500 GPM Vacu-Matic Filter Sets Maximation Records

MAXIMATION— the science of obtaining maximum production in machining and grinding operations while simultaneously paring costs has received fresh new impetus with the development of the Hoffman Hi-Flo Vacu-Matic filter capable of handling water soluble oil coolants in quantities from 200 to 2500 GPM. The new Hoffman Hi-Flo Vacu-Matic filter provides a record 20 to 50% savings in grinding wheels, honing stones, broaches and other edge tools and is a significant forward step in modern metal working techniques. Basis of development is long experience with 40, 60, 80 and 120 GPM filters.

Dirty Coolant Responsible

Metal chips, solid abrasives, grit and dirt or fine particles in coolants are invariably responsible for below rated capacity performance of grinding and finishing machines. Dirty coolant means shorter useful tool, wheel, coolant life — more rejects, higher maintenance, material, labor costs — frequent down time for tool sharpening, in-the-machine-adjustments and sump cleaning. The new high capacity Vacu-Matic filter handling flow rates from 200 to 2500 GPM has been designed and engineered by Hoffman to solve the dirty coolant problem.

Positive Filtration

Filter medium for the new Vacu-Matic is a special, low cost, easily replenished paper on which solid particles are deposited. Coolant is drawn through the filtering paper by negative pressure with the dry sludge remaining on top of the paper. When sludge reaches a preset thickness, the filter paper is automatically indexed by a pressure differential switch and new paper moved over the vacuum area. Water-free sludge and spent filter paper drop off into their respective tote boxes for easy disposal.

Design and Engineering

The Vacu-Matic is simple in design — virtually trouble-free in operation — and suitable for all grinding and machining operations using water soluble oil coolants. Operation is entirely electrical and continuous. *There are no fussy solenoids, air cylinders, intricate inter-locking control valves, etc. Paper is indexed automatically.* Shut-off of dirty coolant through the filter is unnecessary. Since "plugging" of the filter areas by hydraulic or trampoils has been eliminated, coolant flows continuously. Separation of spent filter paper, sludge and chips is entirely mechanical. Through the process of aeration, coolant temperature remains constant at ambient room temperature or below. Coolant sweetness precludes the possibility of bacteria growth. Another design feature is the reduction of the service tank requirement. Gravity feed of dirty coolant to filter is possible where plant layouts permit.

Numerous Competitive Advantages

The use of the Vacu-Matic filter in grinding and machining operations makes it possible to obtain numerous competitive advantages that add up to higher speeds, faster feeds and better finishes. Among them are:

- Removal of all chips, abrasives, dirt and other contaminants with an overall efficiency of 98%.
- Virtual elimination of down time.
- Protection against loading of grinding wheels.
- A four times greater cake than obtainable by conventional gravity flow through the paper.
- Nominal filter paper costs.
- Delivery of dry sludge without coolant carry-over.
- Minimization of coolant loss.
- Automatic and self-cleaning operation.
- Improved working environment.
- Reduction in maintenance costs.
- Longer useful life of equipment, oils, coolants.

Without cost or obligation, Hoffman engineers will provide data on filtering equipment to suit your needs. Their recommendations are based on the nature of the task and long experience in the improvement of manufacturing technology. To check on the use of the new Vacu-Matic filter and how it will pay for itself in your plant, send for the free Vacu-Matic Bulletin FB 107...

Write Dept. LR, Hoffman Industries, Inc., Industrial Filtration Division, Thompson Road Plant #1, Syracuse 6, New York.

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THE COVER

Partial to comfort in your clothing? The self-contained, air-conditioned suit worn by the man at the left gives him comfort in temperatures as low as —40 F and as high as 135 F. Developed for the Navy by Westinghouse, the suit is heated or cooled by thermoelectricity—send current through the thermocouples one way and it heats; the other way, it cools. Two small fans circulate conditioned air around the wearer and to his face mask for breathing. The air-conditioning unit is shown being fitted into the back of the suit.

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The engineer is a scientist who brings the discoveries of science to the world in usable form. More and more, he needs understanding not only of science and technology, but of the real needs of people.

EXTERNALLY PRESSURIZED GAS BEARINGS.....**H. C. Rothe** 45

Don't expect them to solve all bearing problems. They've no place in ordinary machinery. When you want extreme low torque, or deal with certain other extreme conditions—then, the gas bearing.

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A state-of-the-art report on the working of metals. Electrolytic and ultrasonic machining, spark erosion, chemical milling, plasma jets: Grinding, cutting, forging, extrusion—here are the facts.

THE COAL-BURNING CLOSED-CYCLE GAS TURBINE.....**C. Keller and W. Gaehler** 61

It's heavy, so it's for stationary installations. But the closed-cycle gas turbine, with its noncorrosive working fluid, stays clean, and its cooling water—pure waste heat—is available for heating.

BIMETALLIC PIPE.....**Dan Christopher** 68

It began 90 years ago, with lead-encased tin pipe. The idea remains the same: Strength outside, corrosion resistance inside. Today, one firm expands the lining hydraulically into the basic pipe.

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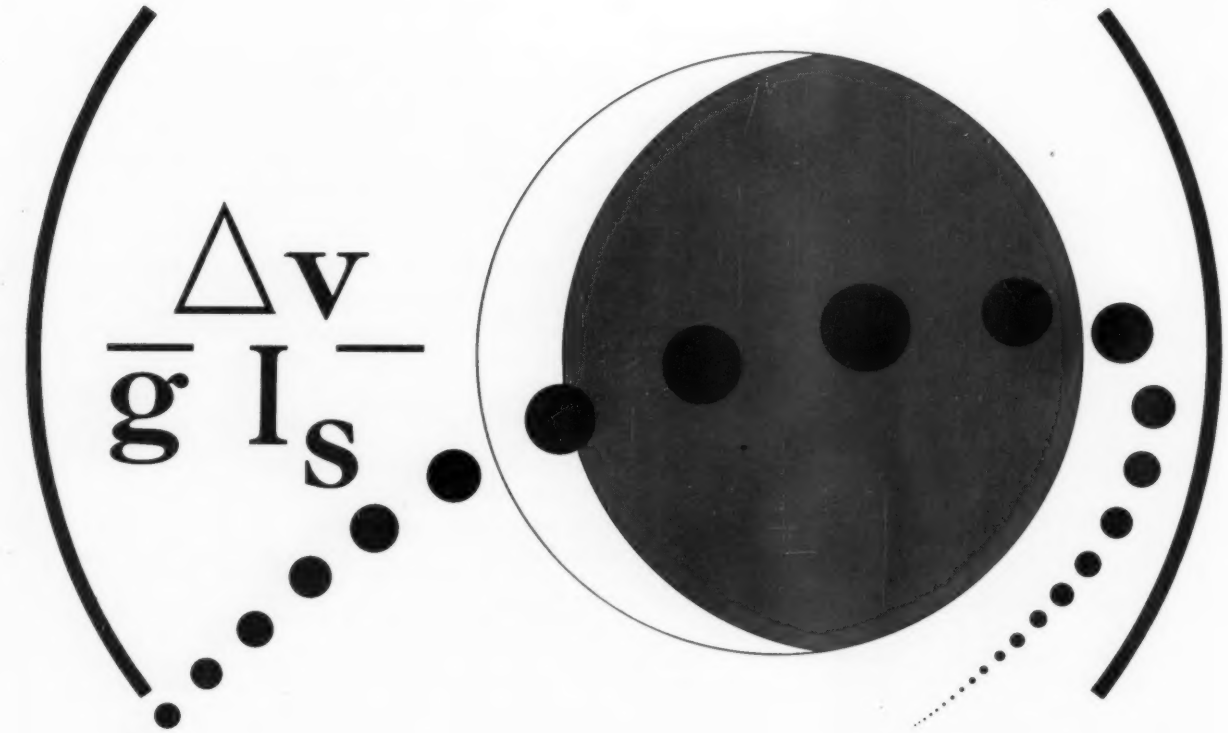
America's new Saturn space vehicle will take off hundreds of times inside IBM computers before reaching the launching pad. It took more than a thousand test firings to develop the early rockets. Yet only 10 research firings are scheduled for Saturn—a rocket-powered vehicle vastly more intricate. ▪ The difference will be made up in simulated flights on two IBM 7090 computers delivered to the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration at Huntsville, Alabama. ▪ Saturn is designed to send payloads of tons into orbits around the earth, to the moon and back, and deep into outer space. These trips can be simulated on IBM computers in a matter of hours, using mathematical equations to calculate results of the "flight." Huntsville scientists say the simulated flights will save years of time and many millions of dollars. ▪ In business as well as science, problems made up of many complex parts can frequently be solved with IBM computers and data processing systems.

IBM WORLD TRADE CORPORATION **IBM**



how to circle the moon without leaving the earth

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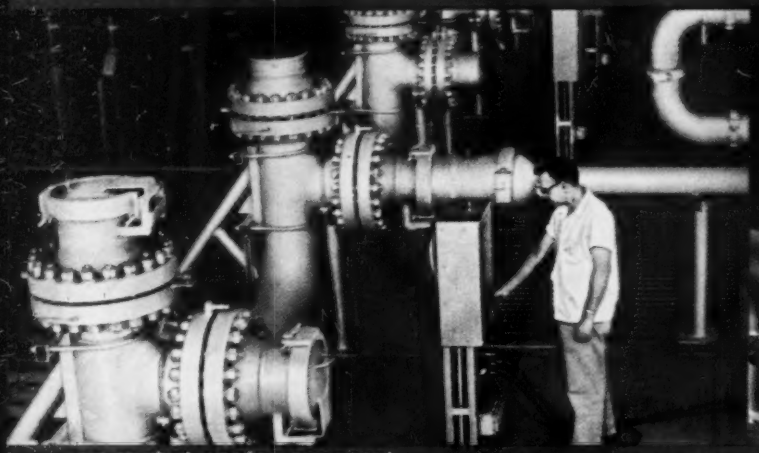

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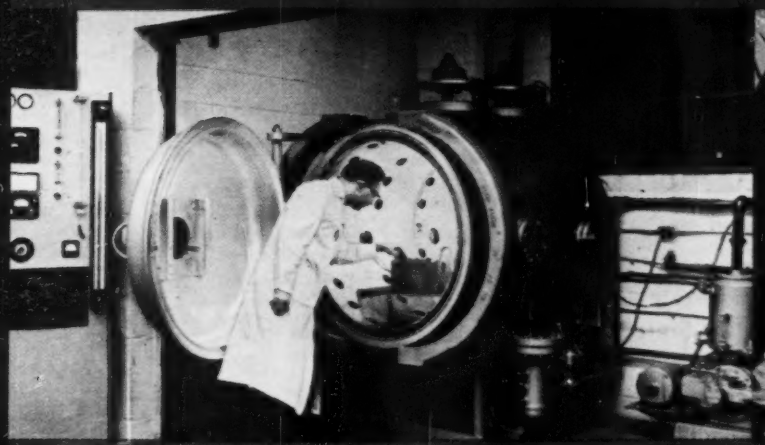

on guided missile component
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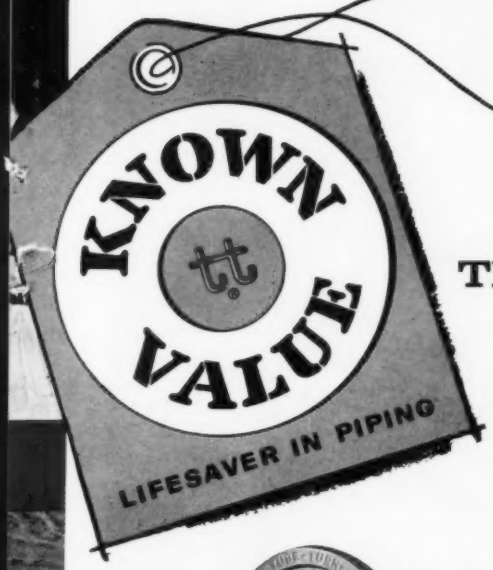

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in easier installation
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If your operations require quick or frequent access to pipe ends, tank or vessel openings, TUBE-TURN Hinged Closures provide a swift, safe and economical solution. So simple to operate, one man can open and close even the largest TUBE-TURN Hinged Closure in a matter of minutes. No hammering, no tugging, no wrestling with massive caps or flanges. Just loosen the yoke bolts, swing back the head, and the opening is fully exposed and accessible.

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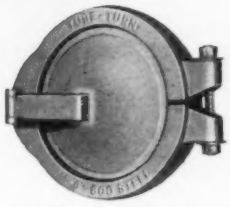

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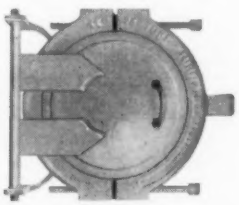

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Almost any tubing component you may need—simple or complex—can be mass-fabricated by Bundy. If you are planning a new product, Bundy specialists will work with you at any time to iron out kinks in tubing problems. Or perhaps Bundy engineers can help you simplify the design—and cut costs—of existing tubing components. And when you specify Bundy you get superior tubing. Bundyweld® meets ASTM 254; Government Specification MIL-T-3520, Type III. Phone, write or wire: Bundy Tubing Company, Detroit 14, Michigan.

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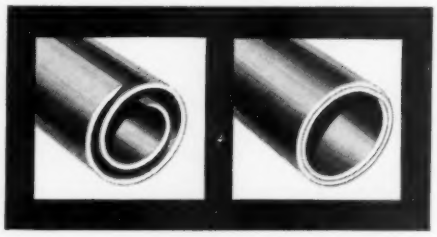

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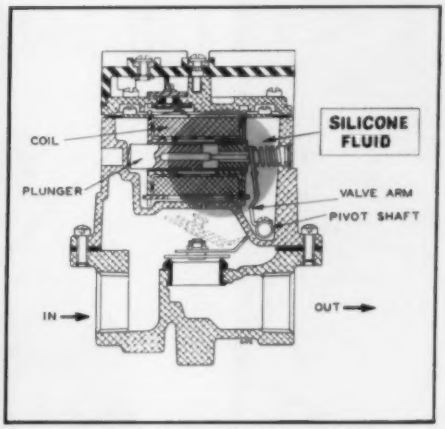
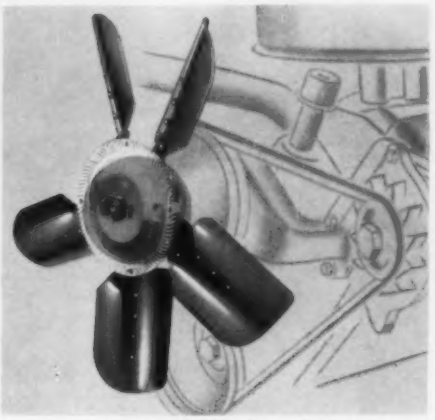
SILICONE NEWS from Dow Corning

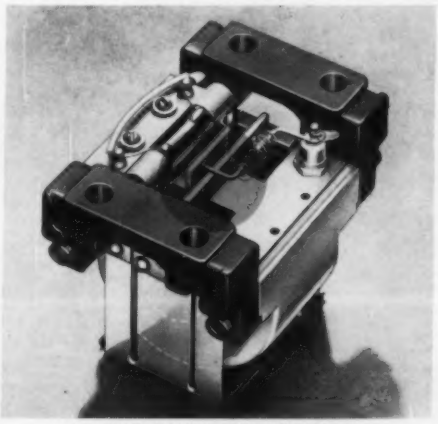
For Designs That Perform



SILICONE DAMPED CONTROL VALVES



SILICONE COUPLED FAN DRIVES



SILICONE DAMPED ACCELEROMETERS

New Fluids Assure Accuracy

Here's why Dow Corning silicone fluids improve performance of mechano-fluid devices and controls. They maintain near-constant viscosity over a wide temperature span; exceptional resistance to oxidation and to breakdown due to shear; and fine dielectric properties. In service, these silicone liquids don't sludge or gum; don't corrode metals nor cause rubber to swell.

Uniform Damping From the arctic to the tropics, behavior of Dow Corning silicone fluids remains virtually constant. As indicated by performance in a torsional vibration damper, damping effect of silicone fluid decreases in the ratio of 3 to 1 over a temperature range from —40 to 160 F; a petroleum hydraulic fluid decreases in the ratio of 2500 to 1.

Damping Medium	Pounds of Damping Force Required to Actuate Against Viscous Drag	
	at —40 F	at 160 F
Dow Corning 200 Fluid 30,000 centistoke grade	210	70
Petroleum Hydraulic Oil (Very high viscosity)	70	0.028

Compressibility Too Formulated to retain its desirable characteristics and also have good compressibility at high pressures, a silicone fluid for "liquid springs" for aircraft landing wheels makes possible a 30% smaller oil chamber; assures uniform performance over wide temperature range.

Aid to Miniaturization The near-ideal silicone fluids also help to reduce size and weight of accelerometers, fan drives, radar buffers, differential pressure cell transmitters, panel instruments and truck scales.

For more information about silicones and their use in mechano-fluid devices, contact the Dow Corning office nearest you, or write Department 7618.

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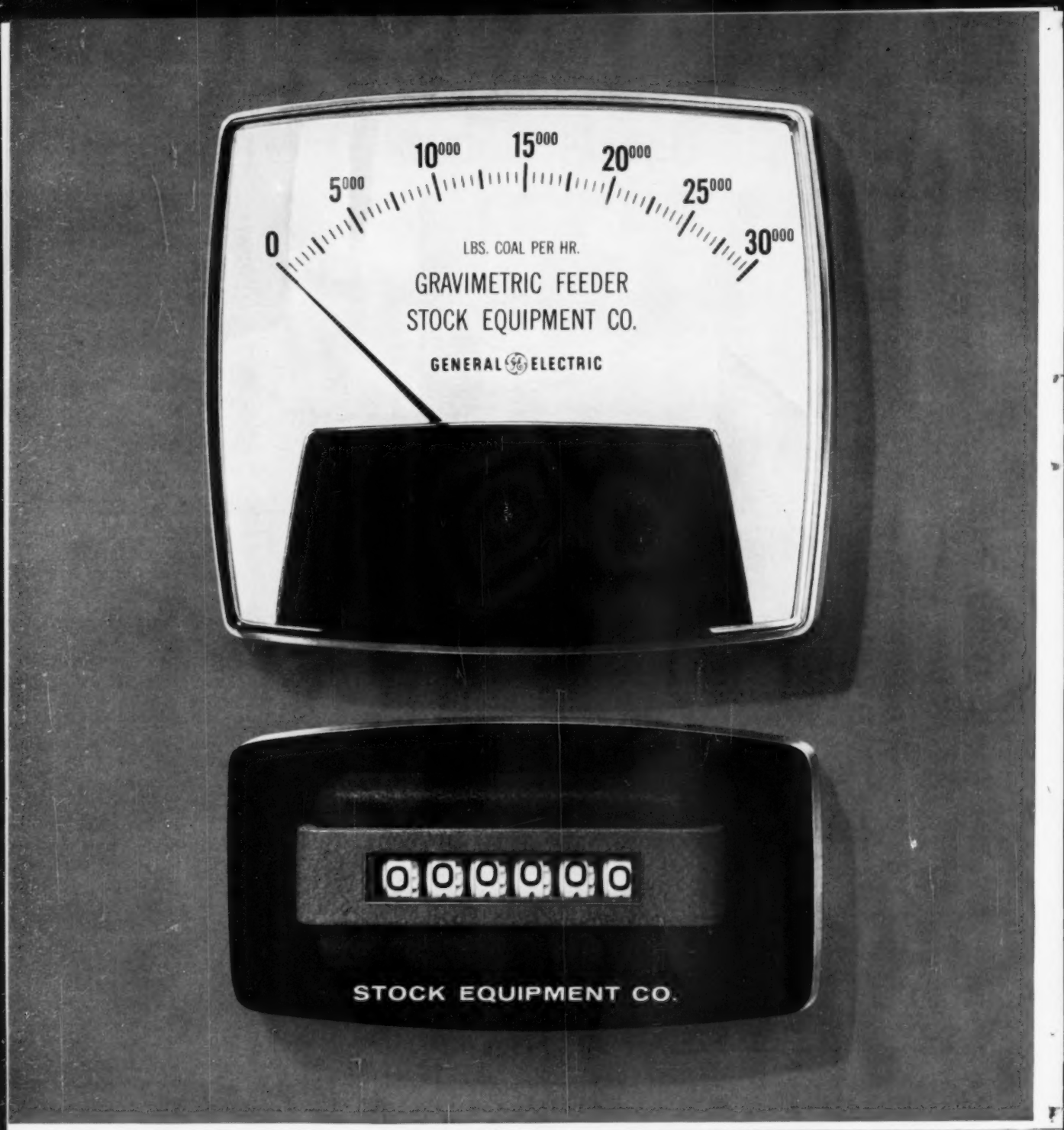

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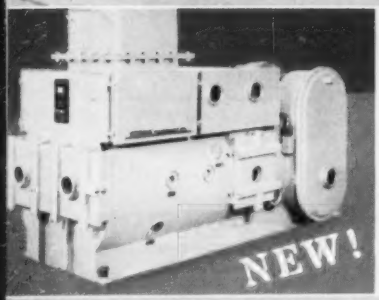
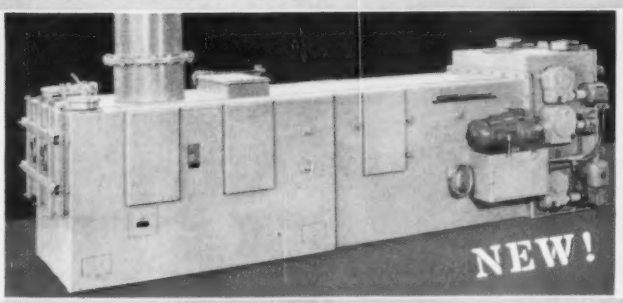
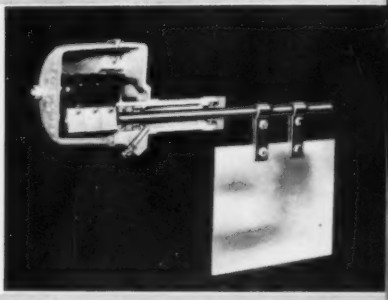


GRAVIMETRIC FEEDERS
Weigh and Feed



VOLUMETRIC FEEDERS
Feed Sticky Coals



STOPPAGE ALARMS
Two Types

S-E-Co. GRAVIMETRIC FEEDERS ALSO INDICATE COAL FLOW RATE AND TOTAL COAL

S-E-Co. Gravimetric Feeders for pulverizers or cyclone burners give reliable and useful indication of rate of coal flow and of total coal consumption.

The rate of coal flow through each feeder is determined by the speed of the head shaft. S-E-Co. Gravimetric Feeders discharge exactly 100 pounds of coal per turn of the head shaft, so the weight of coal per hour is directly proportional to RPM. The indicating instrument which is provided shows the coal flow rate directly in pounds per hour. A feed rate signal can also be supplied as required for recording instruments or for feedback into the control system.

Total coal flow is given by the number of revolutions of the feeder head shaft. The coal integrator is simply a counter driven by pulses taken from the head shaft. Absolute accuracy with no instrument drift is thus assured. The integrator reading times 100 is the total coal weight in pounds. The same pulse for every 100 pounds is ideally suited for entering coal flow information into data logging equipment. If preferred, pulses can be provided instead for any multiple or submultiple of 100 pounds.

S-E-Co. Gravimetric Feeders offer the instrumentation that helps attain the peak of perfection in plant operations. From indication of rate of coal flow in pounds per hour, exact balancing of fuel to each mill or cyclone is easily achieved. The instantaneous station heat rate can be determined quickly by a simple, *direct* procedure. Accuracy in the indication of total weight of coal burned means better records and hence better plant results, as well as proper maintenance scheduling. The advantages become even more pronounced with increasingly automatic control or with computer control.

One of the factors contributing to the precision of coal flow measurements with all S-E-Co. Feeders is their unusually high and non-varying volumetric efficiency. Regardless of whether your coal is wet and sticky, or dry and dusty, or frozen and full of lumps, the indication given of coal flow rate is consistent. With S-E-Co. Gravimetric Feeders, fluctuations in the coal density resulting from varying size consist, moisture, or compaction are eliminated.

For further comments on plant operation with S-E-Co. Gravimetric Feeders, *send your inquiry to*

STOCK EQUIPMENT COMPANY

729 HANNA BUILDING • CLEVELAND 15, OHIO

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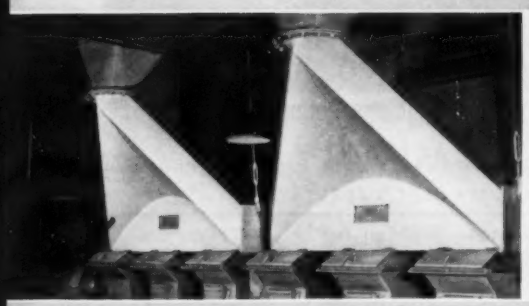
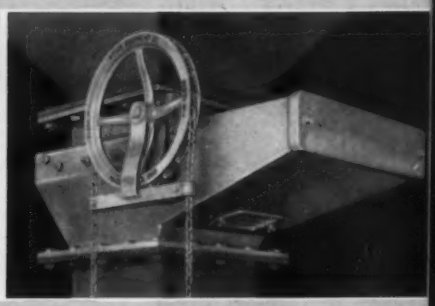
S-E-Co. QUALITY PRODUCTS



CONICAL NON-SEGREGATING
COAL DISTRIBUTORS

COAL SCALES
Two Basic Sizes



COAL VALVES
6" to 60" — Many Styles

SEE RAPID MOTION WITHOUT BLUR

STROBOTAC

for Speed Measurement and Motion Analysis of these and many other Mechanical Actions

- Peak light intensity is as high as 4 million beam candlepower.
- 1-to 3-microsecond flash duration freezes motion, lets you see details you've never seen before.
- Measures speeds to 25,000 rpm directly; useful to 250,000 rpm.
- Many other features — Write for the Strobotac Bulletin.

Type 1531-A Strobotac® Electronic Tachometer and Motion Analyzer . . . $260

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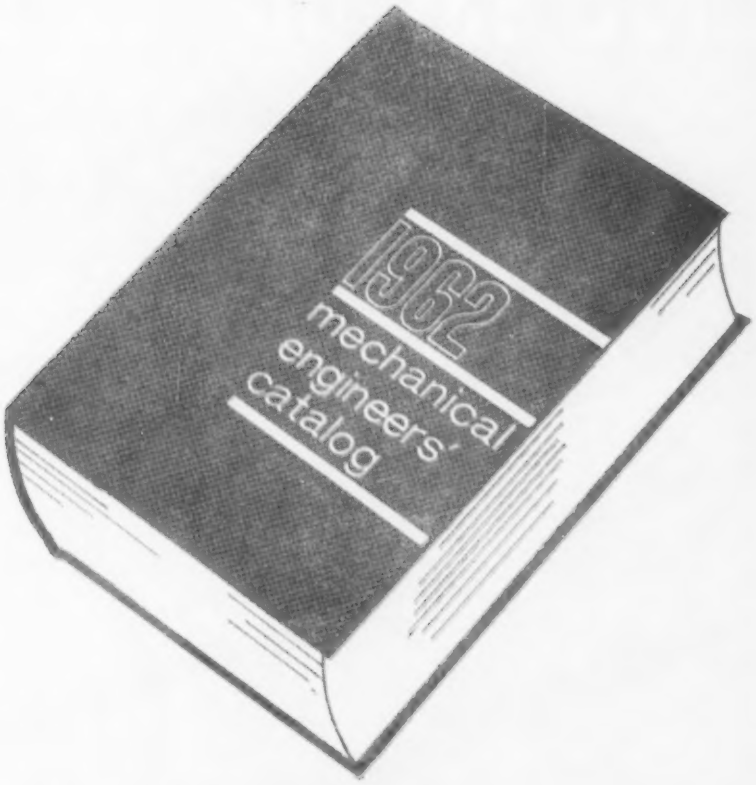


ARE YOUR PRODUCTS GETTING THEIR CHANCE TO BE CHOSEN?

Very soon, the 1962 Mechanical Engineers' Catalog will be on the press. When it is distributed this Fall, those companies who advertise in it will be in a position to capitalize fully on 1962's growing markets. Their advertisements will increase their products chance to be chosen by the mechanical-engineering profession.

This year, more than 20,000 copies of the Catalog will be distributed in response to individual requests—most of them from ASME members. Each copy of the Catalog is used by seven other engineers as well, to select equipment and locate suppliers.

In your own work, you probably know how helpful advertising in the Catalog can be to a company's sales. By providing photos, dimensions, operating data and other information, advertisements help you specify and buy.

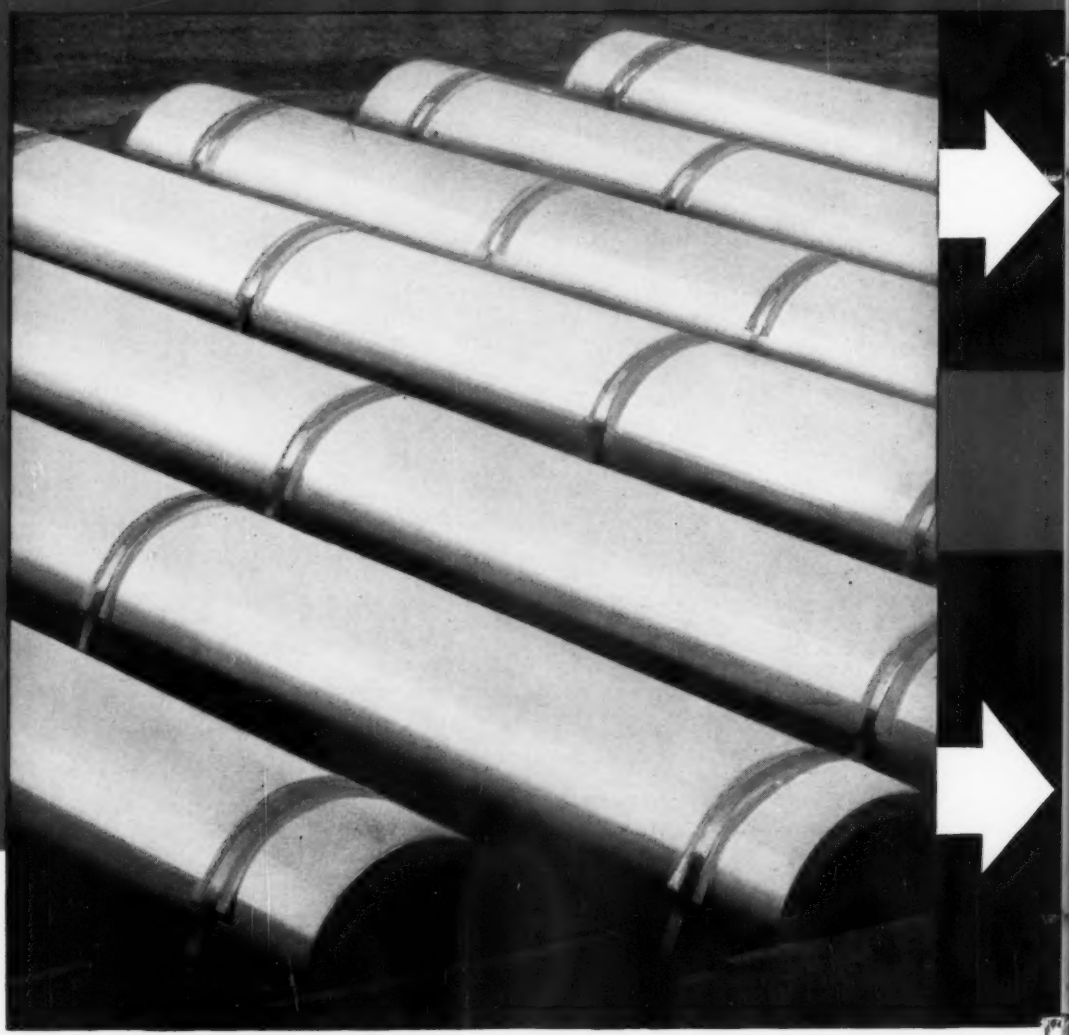
Is your company planning to be an advertiser in the 1962 Mechanical Engineers' Catalog? If so, it is taking advantage of one of the best ways to bring its products to the attention of the mechanical-engineering profession.

1962
MECHANICAL ENGINEERS' CATALOG

Published by the American Society of Mechanical Engineers

new nuclear plants choose

FULFILLS THE EXACTING
HEAT EXCHANGERS



Centrifugal stainless steel castings readied for shipment by U.S. Pipe

The Government's new SPERT III nuclear plant at the National Reactor Station near Idaho Falls, Idaho, operating since December, 1958 to study nuclear reactor safety, uses U.S. Pipe's centrifugally cast stainless steel pipe for its coolant system.

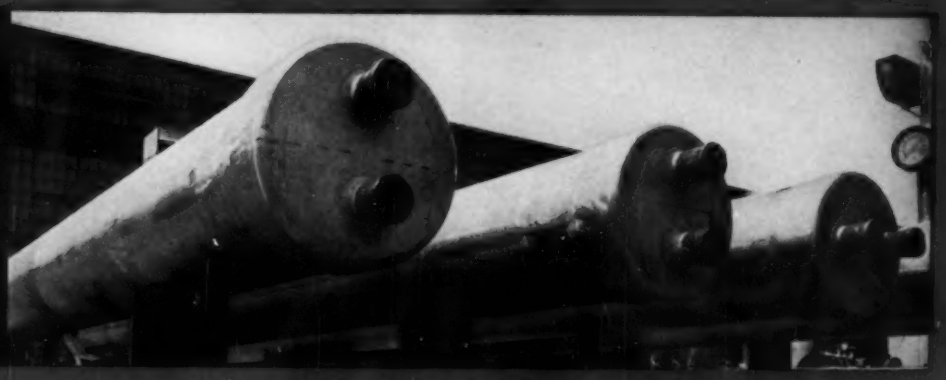
SPERT III is classified as a high pressure, high temperature, light water moderated and cooled reactor. Its versatility permits transient tests under various initial conditions of pressure, temperature, and coolant flow. For example, pressures ranging from atmospheric to 2,500 psi and water temperatures from 68° to 668° F.

Another new nuclear power plant, engineered and constructed by Stone & Webster for Yankee Atomic Electric Company, is using centrifugally cast stainless steel heat exchanger shells made by U.S. Pipe and fabricated by the Southwestern Engineering Company in Los Angeles, Calif.

Stainless steel, centrifugally cast, made to rigid specifications, may be the answer to your piping or heat exchanger problem. For more information, write or call:

centrifugally cast stainless

REQUIREMENTS OF NUCLEAR AND COOLANT SYSTEMS



Shop-fabricated heat exchanger shells of centrifugally cast stainless steel ready for shipment to the Yankee Atomic Electric plant at Rowe, Mass.

Subassemblies of primary coolant piping of centrifugally cast stainless steel being installed in SPERT III.

ASA PRESSURE PIPING CODE STATUS

Approval has been granted under this code for the use of centrifugally cast austenitic pipe for nuclear piping by Nuclear Case N-5. This case appeared in the April, 1960 issue of MECHANICAL ENGINEERING. Reprints on request.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL & TUBES · U.S. PIPE · DIVISION

BURLINGTON, NEW JERSEY

SALES OFFICES: BURLINGTON, HARTFORD, BIRMINGHAM, CHICAGO, CLEVELAND, DALLAS, LOS ANGELES, NEW YORK, PITTSBURGH, SAN FRANCISCO

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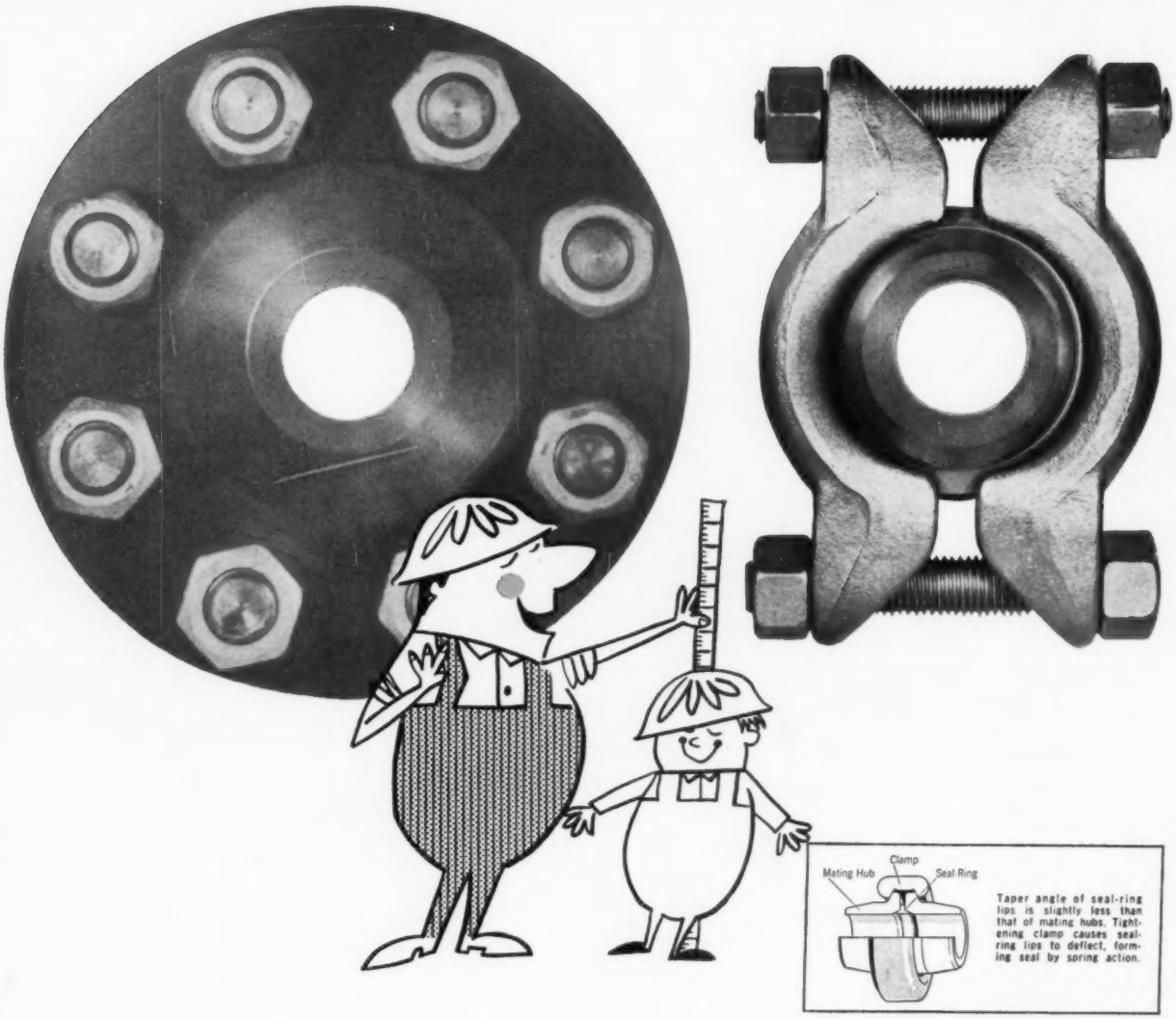
Grayloc Pipe Connections Save ⅓ the Space



Clamp
Mating Hub
Seal Ring
Taper angle of seal-ring lips is slightly less than that of mating hubs. Tightening clamp causes seal-ring lips to deflect, forming seal by spring action.

GRAYLOC® pipe connections are up to one-third smaller than flanged connections with comparable maximum pressure ratings. They save wasted space — cut unit weight and assembly time drastically.

An all steel assembly, GRAYLOC employs a pressure aided seal that can be assembled or disconnected in minutes. The heart of the assembly — the seal ring — is completely reusable.

Although GRAYLOC connections are manufactured in standard stock sizes from 1″ to 30″, special sizes for special applications are available on request. Corrosion resistant metals can be provided on short notice.

You can use GRAYLOC connections in your piping system. They'll save you maintenance and assembly time, space and money. To learn how, write for the new GRAYLOC catalog.

GRAYLOC SALES DIVISION

GRAY Tool Company

6112

P. O. BOX 2291 • HOUSTON 1, TEXAS • Riverside 7-1240

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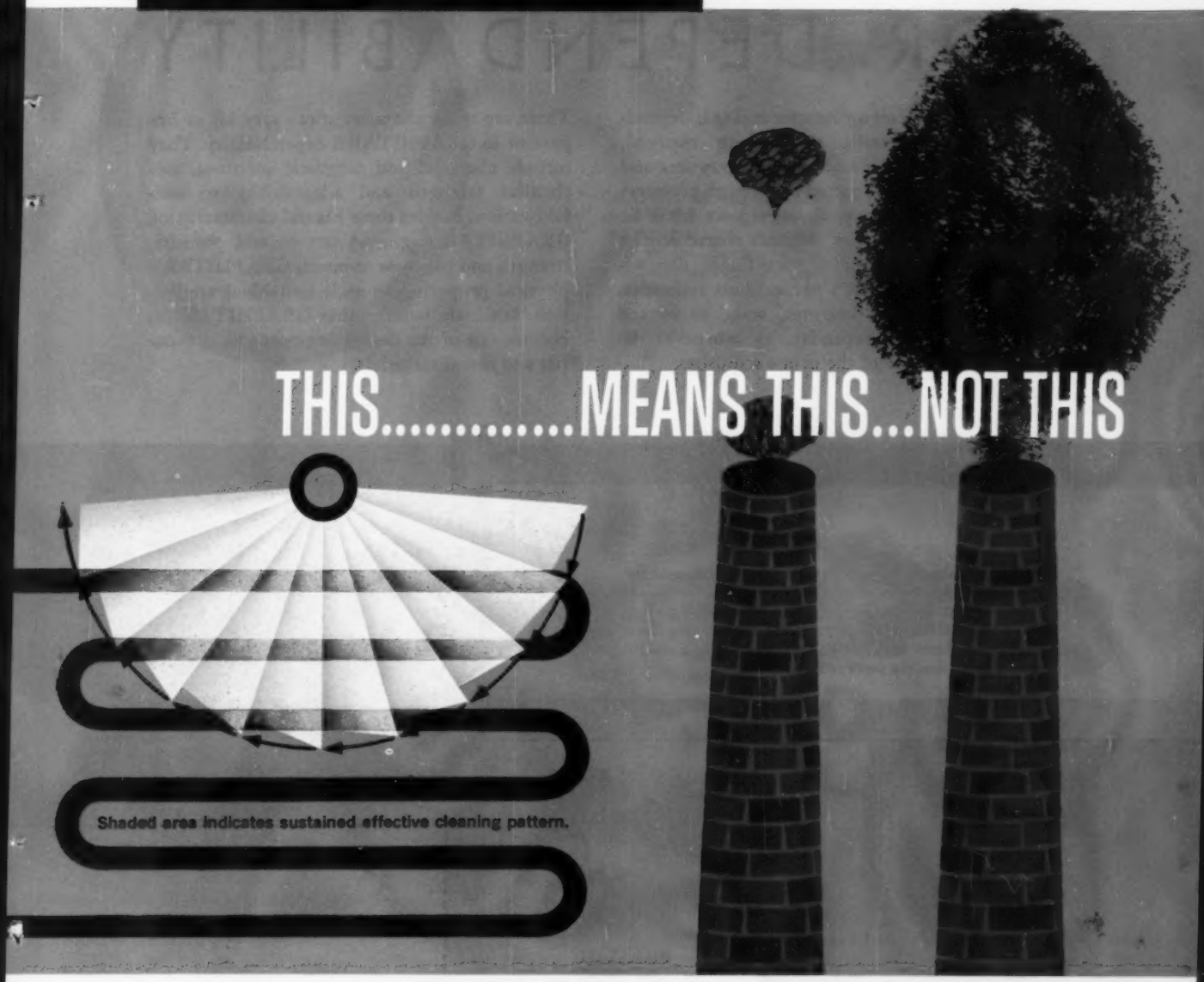
Diamond developed for more economical power...

AIR PUFF BLOWING=CLEANER BOILERS... AN APPRECIATIVE PUBLIC



Two of today's more critical conditions for efficient steam generation . . . clean boilers and acceptable stack emission . . . are assured with Diamond Air-Puff Soot Blowing Systems.

Increased cleaning efficiency is obtained because high density air is used as the cleaning medium and emitted in sustained high pressure puffs that are independent of receiver capacity or compressor size. Also, because no air is emitted at ineffective low pressures, there's greater economy in *use* of cleaning medium.

Acceptable stack emission is achieved because intermittent air puff blowing eliminates more concentrated and objectionable emission caused by continuous blowing arcs or blowing puffs of longer duration. In the standard Diamond Air-Puff System, intervals between air puffs are determined by the time required for build-up to optimum blowing pressure; however, if more positive control of stack emission is desired, intervals can be regulated by a simple valve adjustment.

The Diamond Air-Puff Blowing System for new *or* existing boilers of any type and capacity is further evidence of why "Diamond developed" means more economical power. Our engineers will be happy to discuss its application to your units. Call, write or wire for complete information . . . and thank you for reading our advertisement.

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DIAMOND POWER

This is the new trademark of Diamond Power . . . a symbol of quality, integrity and progress . . . in products, systems and service.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio
DIAMOND SPECIALTY LIMITED, Windsor, Ontario

GRAPHITAR®

(CARBON-GRAPHITE)

FOR DEPENDABILITY

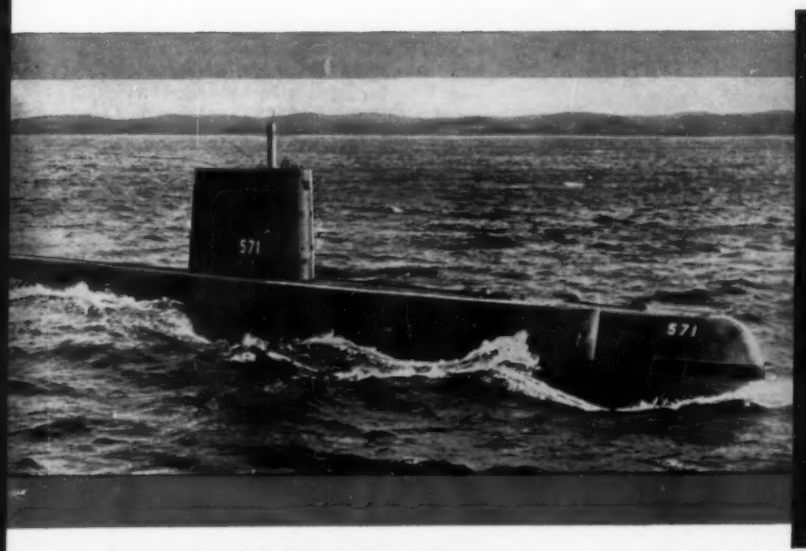
GRAPHITAR'S own character makes it dependable. A non-metallic engineering material, formed from carbon and graphite powders and a special binder, compacted under high pressures and furnaced at temperatures up to 4,500°F., GRAPHITAR possesses inherent characteristics that give finished parts exceptional dependability. GRAPHITAR'S natural heat resistance, for example, gives bearings, seals, vanes and rings exceptional dependability whenever dependability is one of the prime requisites.

There are other characteristics every bit as important to GRAPHITAR'S dependability. They include chemical and magnetic inertness, mechanical strength and adaptability to self-lubrication. Besides these natural characteristics, GRAPHITAR engineers can control porosity, strength and hardness to match GRAPHITAR'S physical properties to each individual application. It's little wonder that GRAPHITAR has become one of the design engineer's most versatile and useful materials.

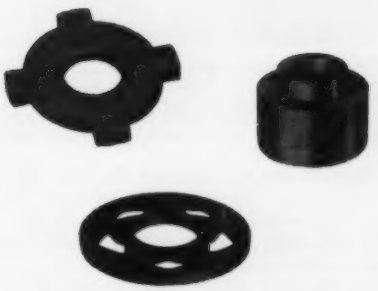
In this laboratory test stand, oxidation-resistant GRAPHITAR parts are being checked under simulated operating conditions. Similar tests have proven that, when GRAPHITAR parts are exposed in oxidizing atmospheres at 1,200°F., they show only a weight loss of less than six percent after 200 hours.

With the aid of photomicrographs, engineers at The United States Graphite Company gain valuable information about the microstructure of GRAPHITAR parts. Modern laboratory equipment such as the Metallograph enables engineering personnel to advance product quality for maximum dependability. Extensive and continuing R&D work has always been an integral part of The United States Graphite Company's operations.

GRAPHITAR air/oil seals employed in today's high-speed turbojet engines have established an enviable record for operating dependability. Installed on the main shaft of the turbine, GRAPHITAR seals successfully withstand tremendous shaft speeds and generated heat.



GRAPHITAR bearings in the power reactor pumps of American nuclear submarines have compiled an outstanding record for dependability.



Unusually shaped parts of GRAPHITAR can be molded easily with today's modern techniques. Ears, face slots and outside diameter notches of friction disc above, left, were molded in one operation without need for secondary machining and finishing.

Do you have an application in which GRAPHITAR'S dependability can help solve a tough problem, reduce your costs and improve the operational life of your products? Our engineering staff can help you find out. Our field men can also give specialized, on-the-job consultation. Send for your free copy of Engineering Bulletin #20. Included is helpful information about the properties, characteristics and applications of GRAPHITAR.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Circle No. 128 on Readers' Service Card

R-294-28

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

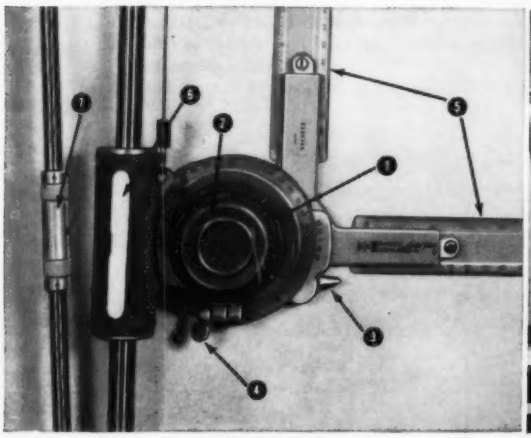
Anything you can do with a drafting machine you can do almost as well with a T-square, triangle and protractor. It just takes a *lot* longer and it's a *lot* harder. That's why so few drawing boards these days are seen "sans-machine."

Every board – and draftsman behind it – has slightly different requirements. This is why there are PARAGON® Drafting Machines by K&E in a variety of tested styles. Just take your pick:

Whatever your angle . . .

Taking a page out of school . . .

A lot of firms employ chalkboards for group work, demonstration, rough planning, and other forms of "communal" drafting activity. If you've got such a board around your shop, we've got just the machine to fit it. Called the "Chalkboard" AUTO-FLOW this is essentially an AUTO-FLOW with elongated horizontal and vertical tracks and special mounting brackets. Whatever the length or height of your chalkboard, there's a Chalkboard AUTO-FLOW to accommodate it.



1. Full 360° indexing with automatic 15° stops, released at a touch, 2. Contour-designed control knob to match shape and motions of the hand, 3. Thumb-release to set in-between angles, 4. Base-line release – located near protractor head for fastest operation, 5. Easily-adjusted, interchangeable scales, 6. Conveniently placed finger-tip brake control to lock or release vertical position, 7. Convenient horizontal motion brake for one-hand operation, sitting or standing.

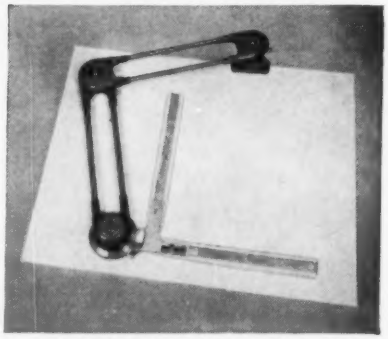
The PARAGON AUTO-FLOW® Drafting Machine is tops – by far the most versatile drafting machine to come along in years. A track-type machine with a wealth of work-saving features, the AUTO-FLOW can simplify your whole drafting operation. The board angle *you* find most convenient will suit the AUTO-FLOW to a "T." And no irksome counterbalance weights or friction brakes are necessary. A quick adjustment of a tension spring wheel puts the AUTO-FLOW in perfect balance – vertically, or anywhere down to the horizontal. The AUTO-FLOW's scales can be moved quickly and locked firmly into *any* position on the board. Both horizontal and vertical motion brakes are designed for rapid, one-hand operation. Smooth, *full-board* action lets you draw straight lines the entire length and width of the board in one continuous motion – something it's impossible to do with conventional machines. And – the *piece de resistance* – the AUTO-FLOW's superbly functional designs puts *all* controls conveniently on, or adjacent to the control head for the easiest operation ever. This engineered control system considerably reduces the number of arm and hand motions needed to produce a finished drawing.

An old dog with new tricks . . .

If you prefer the conventional, "elbow-armed" drafting machine, the PARAGON standard is just your dish. You'll find plenty of refinements here, too. This is *one* "elbow-armed" machine that won't creep or crawl on the board. Just a twist of a thumb screw adjusts for perfect arm balance at any board angle up to 10°. The arms themselves *never* need adjusting. Tension bands are factory-set for years of use. Scales always lie snug and flat on the board and both arms twist freely in either direction. They can be lifted over objects on the board and returned to the same setting with ease. Baselines can be changed instantly, too. A convenient release lets you establish a new baseline in seconds, while maintaining your "0" setting on the protractor. And the PARAGON standard has essentially the same engineered control head that so many swear by on the PARAGON AUTO-FLOW – the biggest time-saver in drafting since paper.

For the sometime user . . .

Maybe you're a design engineer, a chief draftsman, an ex-draftsman "keeping his hand in," or any one of many having only occasional need for a drafting machine. If so, the PARAGON Jr.® (shown below) is your mate. Originally designed for desk use by students, the PARAGON Jr. is ideal for the "part-time" draftsman. Patterned after the PARAGON standard, this compact drafting machine offers all the important features found in its full-sized counterpart, *plus* the convenience of "tuck-away" dimensions. Its combination mounting bracket permits temporary or permanent mounting on almost any desk, board, or table. It will operate efficiently at any board angle up to 25° and will accept any scales with standard chuck plates. Its engineered control head has full 360° indexing with automatic 15° stops, a convenient lock-lever for intermediate settings, and a rapid release for full 360° base-line adjustment while retaining "0" indexing.



And that's the lot – a PARAGON, we hope, for everyone. If the ease and speed of "feather-touch" drafting has a place in your operation, simply fill out and mail the coupon below and we'll show you how the PARAGON of your choice delivers it – like no other drafting machine can.

KEUFFEL & ESSER CO., Dept. ME-6, Hoboken, N. J.

Gentlemen:

Please send me complete information on the K&E PARAGON Drafting Machine(s) indicated:

- ☐ K&E PARAGON AUTO-FLOW Drafting Machine
- ☐ K&E PARAGON standard Drafting Machine
- ☐ K&E PARAGON Chalkboard AUTO-FLOW Drafting Machine
- ☐ K&E PARAGON Jr. Drafting Machine

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NEW

G-R *Pre-Engineered* STANDARDIZED COMPONENT SHELL and TUBE *Heat Exchangers*

Outstanding Purchaser Advantages:

1. Proven construction reflecting many years experience in designing and fabricating custom shell and tube exchangers for the Petroleum, Petrochemical, Chemical and allied industries.

2. Elimination of custom engineering charges.

3. Less costly than custom designed exchangers, permitting a *smaller* appropriation to buy *more* plant facilities.

4. Certified final dimensioned drawings furnished with the quotation.

5. Approval of drawings given with the purchase order, minimizing drafting and transmittal time.

6. Piping layout and support structures can be started without delay.

7. Dome design and port location assure maximum operating efficiency.

8. Maximum tube counts by computer calculation minimize fluid by-pass.

9. Adequate inventories and partial pre-fabrication speed delivery.

10. Full compliance with ASME and TEMA-R Codes, whichever is most exacting, plus G-R quality control.

11. Wide range of shell sizes, surfaces, and pressures to meet all but the most unusual requirements.

12. Acceptable modifications from standard construction provide the flexibility of custom design in meeting individual specifications of large operators.

Get Full Details! Send for your copy of Bulletin No. 101 Today! ▶

Griscom-Russell

THE GRISCOM-RUSSELL COMPANY
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Engineering and Sales Representatives in the Principal Cities

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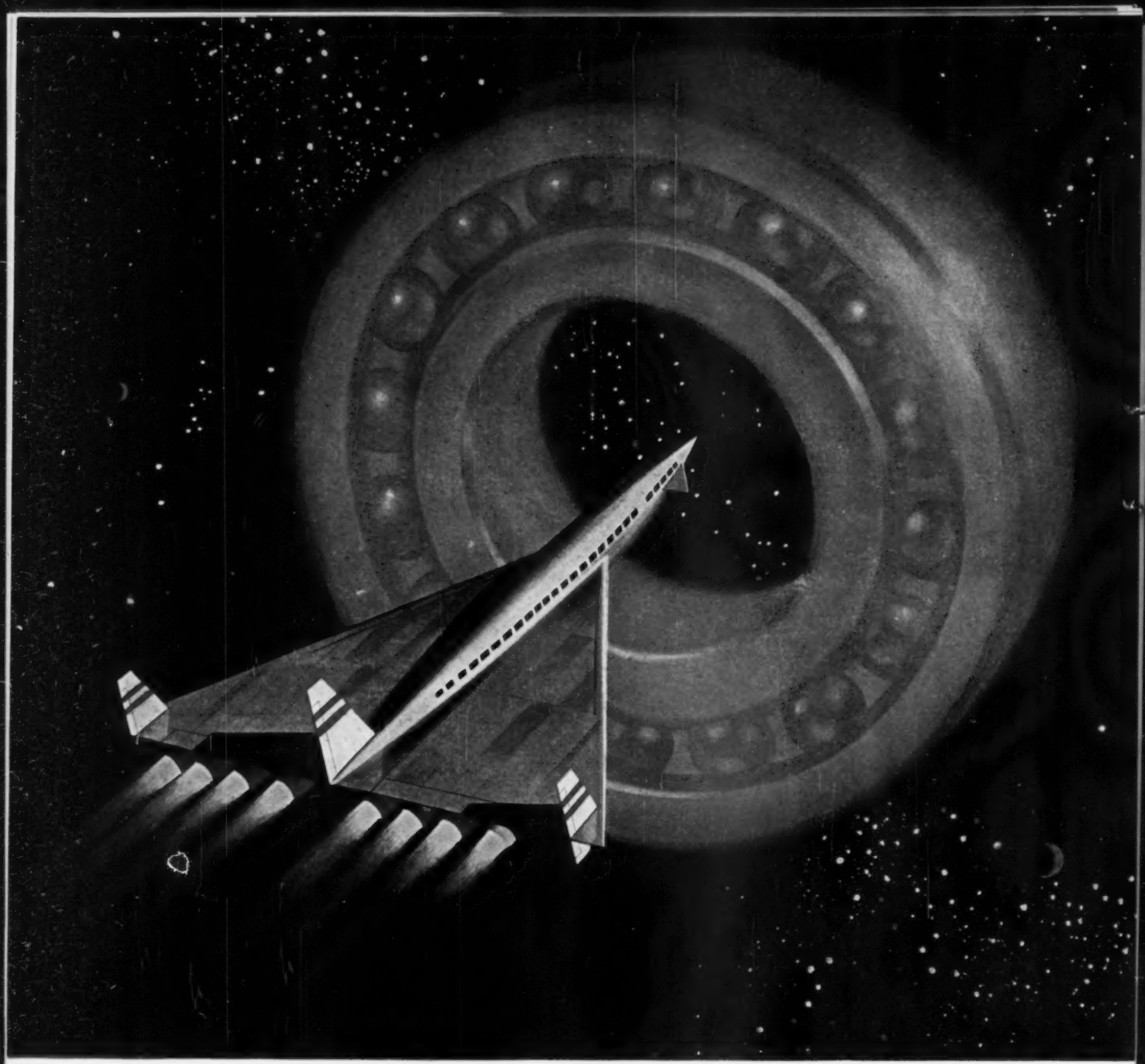

BEARING WITH A RED HOT FUTURE

SKF MOTION ENGINEERING

Advanced ball and roller bearing technology

On special test equipment in SKF's research laboratory, experimental ball and roller bearings are run at temperatures up to 1000° F and above—conditions under which steel becomes red hot and loses its strength, while conventional lubricants burn or boil away. To meet these problems, bearings made of special heat-resisting alloys and exotic new materials are tested and evaluated. New ideas in design and new approaches to lubrication are constantly being investigated.

Bearings to resist extremely high temperatures are needed for improved, high performance jet engines, gas turbines and other equipment. Special SKF bearings have been tested successfully in environments at about 1000° F. Under certain conditions of operation, much higher temperatures are practical.

Research like this is your assurance that SKF will always keep pace with demands for the highest possible performance in all major types of rolling contact bearings —ball, cylindrical roller, spherical roller, tapered roller and precision miniature. SKF Industries Inc., Philadelphia 32, Pa. 6103

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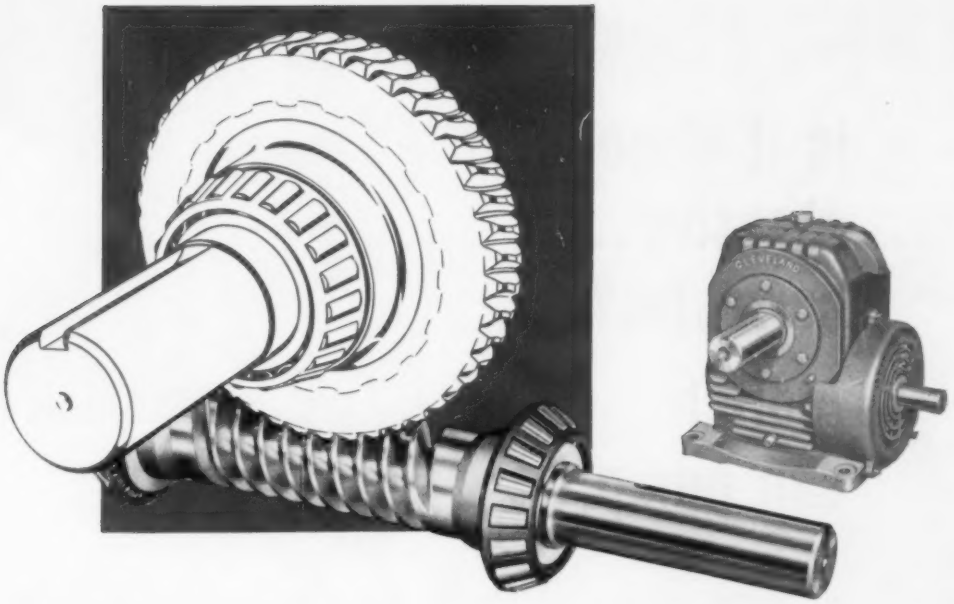


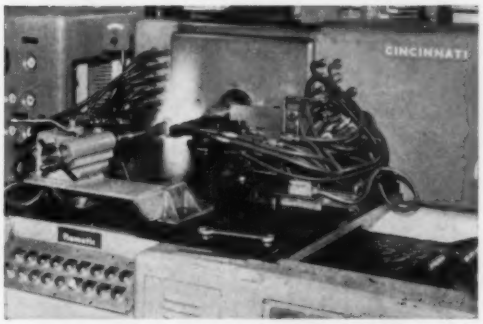
Flamatic-hardened worms help give Cleveland Speed Reducers their longer service life . . .

On all Cleveland Speed Reducers, alloy steel worms are cut integral with the shaft and accurately ground to a high surface finish on both thread flanks. Shaft extension diameter is especially large to permit increased overhung load capacity. Heat treatment is by a special "Flamatic" process—exclusive with Cleveland-made worms. This provides a high degree of hardness throughout the entire thread thickness and well below the worm's root diameter—(See etched worm cross-section).

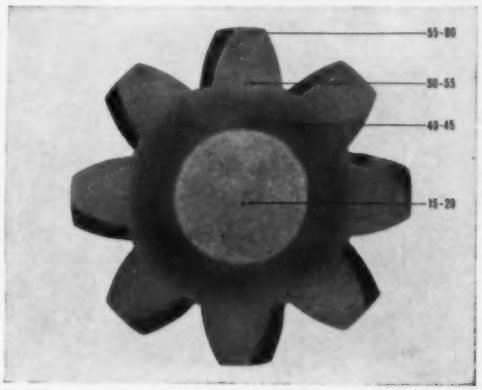
This new worm hardness pattern gives maximum thread strength and resistance to wear without sacrificing the advantage of a medium-hard tough core. Furthermore, the pattern is carried out in the worm shaft extension past the oil seal wearing surface to prevent the shaft being worn and damaged by its oil seal.

Mated with Cleveland's high density centrifugally cast bronze gears, the result is increased wear resistance—much longer trouble-free service life.

Why not write today for your free copy of Bulletin No. 405 showing the latest developments in the Cleveland Worm Gear Line. Or, better yet, contact your nearest Cleveland Representative and get the complete facts.



Worms are Flamatic-hardened in the Cleveland Plant (above) to give them the typical Rockwell "C" hardness pattern as shown in the etched cross-section (below).



CLEVELAND
Worm Gear
Speed Reducers

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3282 East 80th Street • Cleveland 4, Ohio

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Is it viscous... abrasive... corrosive? Aldrich can pump it!

Are you working with hard-to-handle abrasive, corrosive, viscous or highly compressible liquids at high pressures? Are you running into crippling downtime, cost after cost? Get in touch with Aldrich!

Our specialty is the *hard-to-crack* problem in high-pressure pumps. No one has worked through as many tough assignments in such a wide range of applications as we. No one can approach your problem with as much experience at the start. In fact, chances are good that the pump you are looking for has already been developed at Aldrich for an application similar to yours.

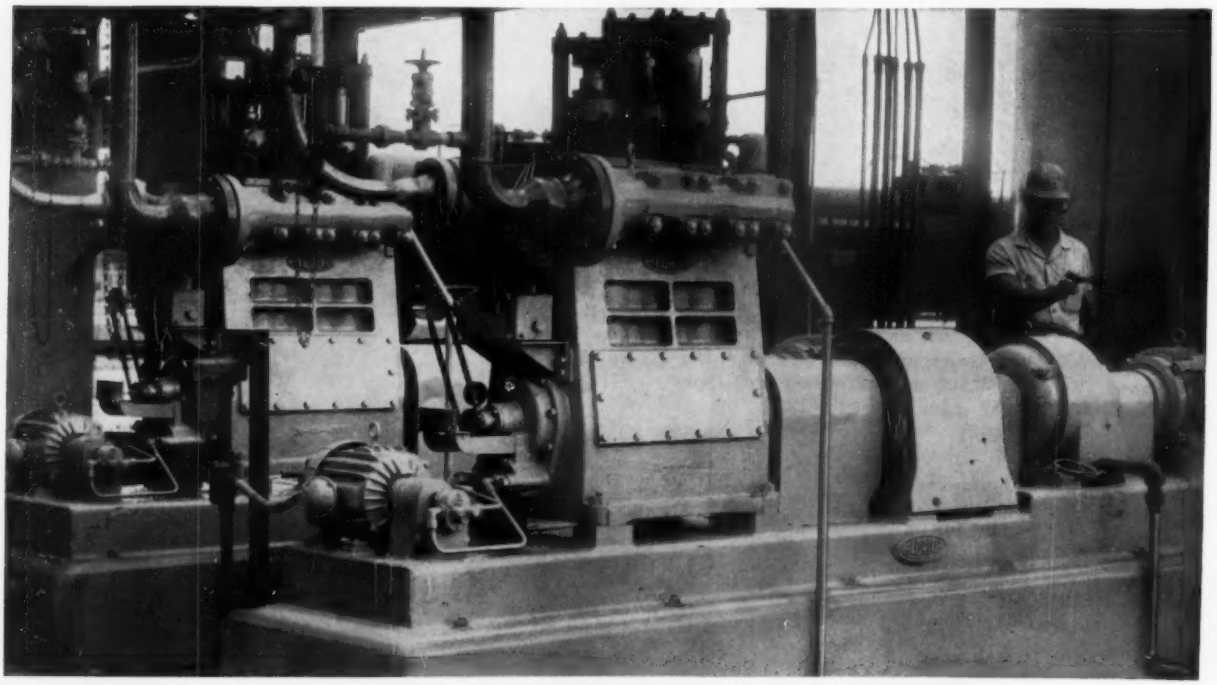
Aldrich pumps are handling such chemicals as: anhydrous ammonia, brine, caustic catalysts, caustics in 50% solution, liquid CO_2, diethylene glycol, di-propargyl ether, hydrocarbons, methanol, amine, naphtha, nitric acid, 9000 SSU oil, silica gel, sodium hypochlorite, sulfuric acid and carbamate.

In addition to getting dependable pump performance from Aldrich, you'll get *service*, geared to the pump user's urgent need to maintain operations. We stock parts for every standard pump we produce in eleven cities in the U.S. and Canada, and give top priority to parts for special pumps.

Write us about your pumping problem today. Sizes range from 25 to 2500 hp, pressures to 50,000 psi. Aldrich Pump Company, 29 Gordon St., Allentown, Pa.

The tough pumping problems go to

ALDRICH



Circle No. 5 on Readers' Service Card

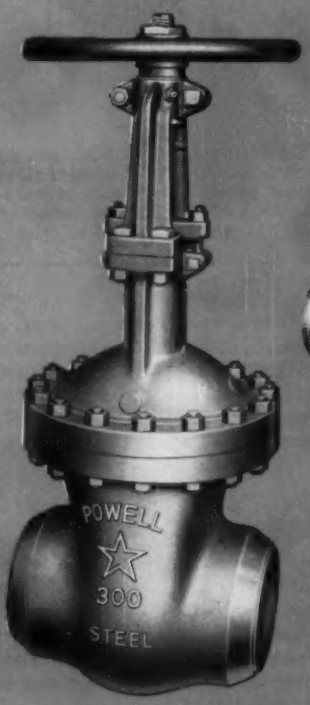
YOU CAN COUNT ON POWELL VALVES

Performance proves it, year after year—you can count on Powell Valves to help you solve the toughest flow control problems of temperature and pressure found in power plants today.

This truly dependable performance results from many things—among them Powell's engineering know-how, accumulated during 115 years of valve manufacture, and the consistent use of quality materials, quality controlled.

Then, too, you can count on getting the Powell Valve you need, when you need it. That's because Powell maintains a network of distributors backed up by factory inventories, warehoused "ready to go."

Get the full story from your nearby Powell Valve Distributor, or write us direct . . . The Wm. Powell Company, Cincinnati 22, Ohio.



300-pound Steel Gate Valve—Fig. 3003 WE. Bolted flanged yoke-bonnet. Outside screw rising stem. Interchangeable solid or split wedges, renewable seats. Sizes, 1" through 30".

600-pound Steel Horizontal Swing Check Valve—Fig. 6061 WE. Bolted cap, renewable seat and disc. Has full flow area when valve is fully open.

2500-pound Steel Pressure Seal Gate Valve—Fig. 125003 WE. Enclosed bevel gears facilitate operation. Valves can also be supplied with spur gearing or motor operators for remote control.

115th year of manufacturing industrial valves for the free world

POWELL STEEL VALVES

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

Circle No. 106 on Readers' Service Card

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of Air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

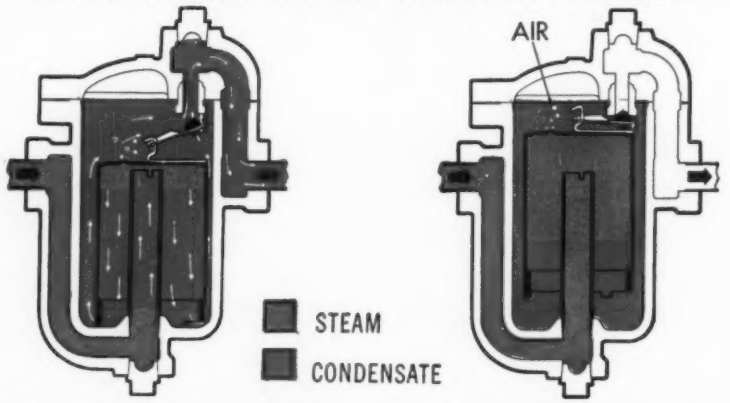
By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

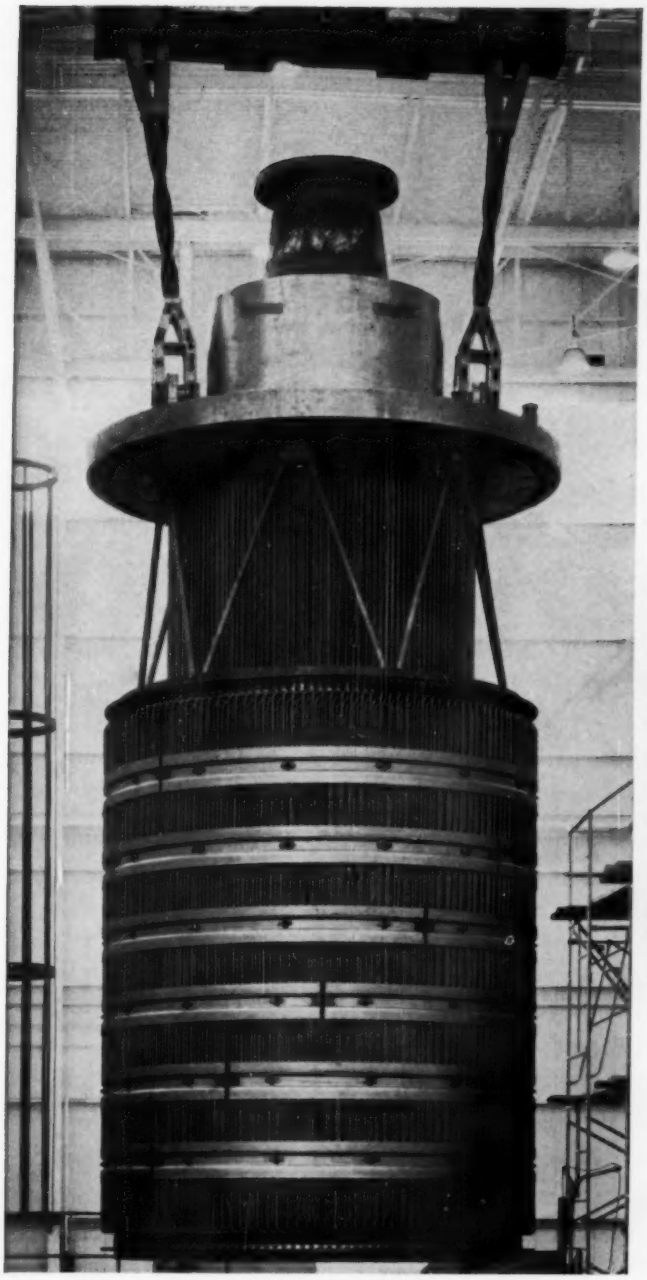
Armstrong Machine Works
8949 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

"See our catalog in Sweet's Plant Engineering File" 813-ST

Circle No. 12 on Readers' Service Card

TOMORROW'S POWER



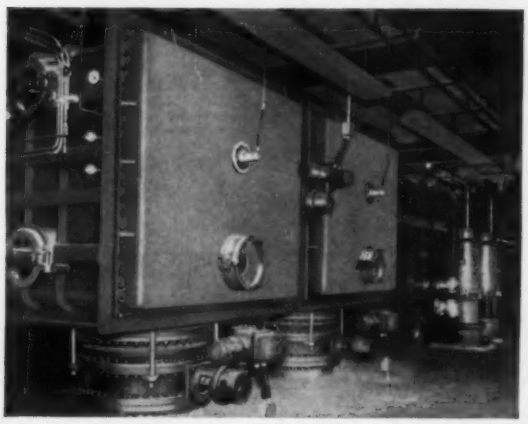
and

C. H. WHEELER / GRISCOM-RUSSELL

COMBINED INGENUITY

AND SKILL BUILT IT.

Three identical Griscom-Russell Vertical Once-Through Involute Tube, Liquid Sodium Heated Steam Generators (one of which is shown here)—have been installed and are being tested at the Enrico Fermi Power Plant built by the Power Reactor Development Corporation. These generators—first of their kind ever built—are an important break-through in the continuing efforts to produce steam from nuclear power more economically.



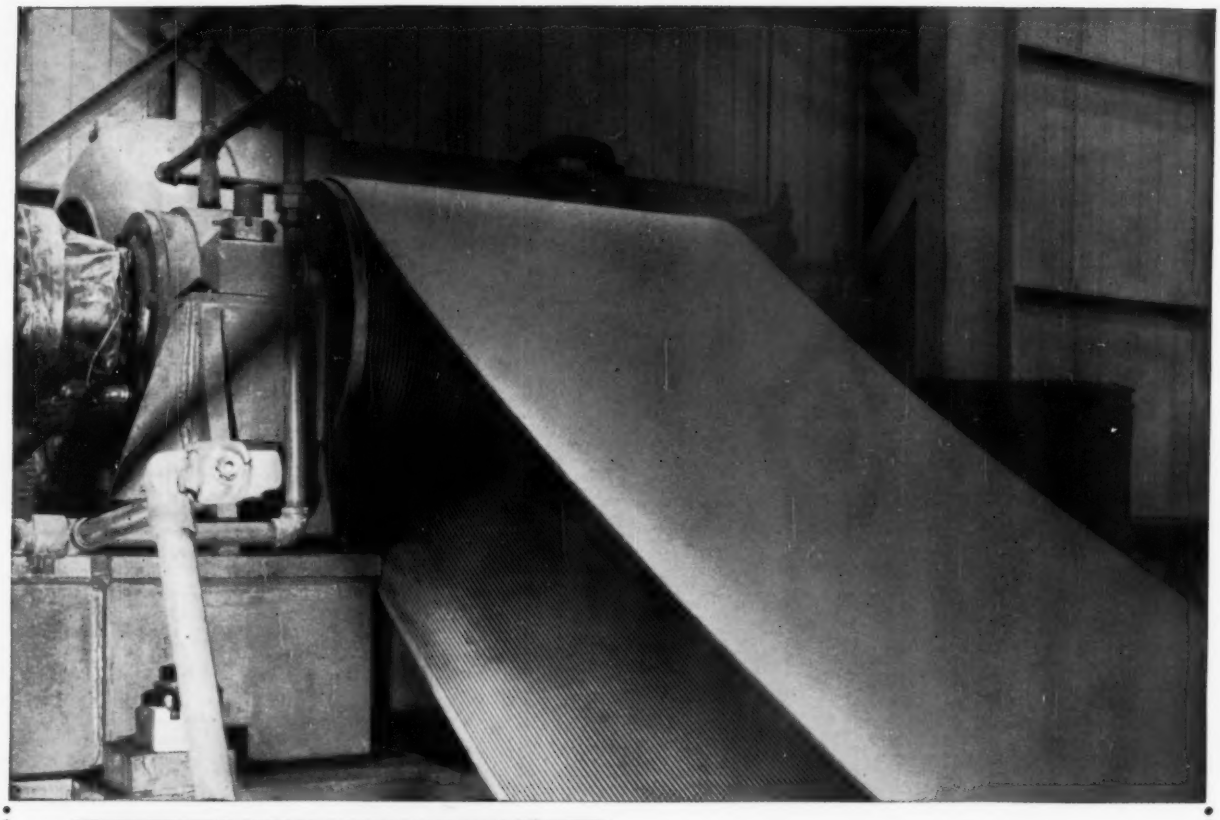
This 50,000 sq. ft. C. H. Wheeler Condenser at the new Indian River Plant of the Orlando (Florida) Utilities Commission, serves the 78,500 (rated capacity) turbine-generator. Its special deaerating features saved money in installation costs. C. H. Wheeler Ejectors, Circulators and the Condensate Pumps shown at the right also serve this new plant.

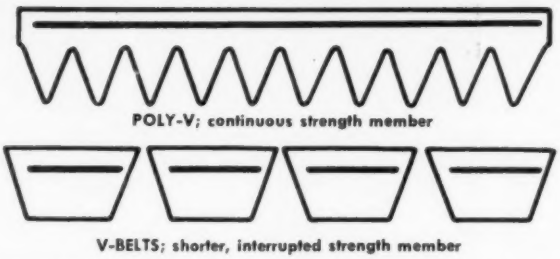
GRISCOM-RUSSELL / C. H. WHEELER

Massillon, Ohio — Philadelphia 32, Pa.

From this combined source you may now select condensers, circulating, condensate and general service pumps, steam jet ejectors, feedwater heaters, evaporators, generator gas coolers, tank heaters, heat exchangers, or special steam generators . . . all engineered and coordinated to meet the performance and space requirements of your power station.

Circle No. 135 on Readers' Service Card





"MORE USE PER DOLLAR"

Poly-V Belt is a single unit with even, uniform pull. Uninterrupted strength member gives much higher hp capacity per inch of drive width. No belt drive delivers as much power in the same space as Poly-V!

Steel Mill Converts to R/M POLY-V BELT on Rugged Hot-Saw Drive!

A 34½" wide R/M Poly-V® Belt of 92 ribs now delivers "power plus" on this punishing hot-saw drive at one of the country's largest steel works. Converting to Poly-V eliminates the problems of a multiple V-belt drive . . . matching, stretching, overloading, whipping and snapping of individual V-belts.

The patented Raybestos-Manhattan Poly-V Drive is a single unit, V-ribbed belt design that mates perfectly with Poly-V sheave grooves, eliminates V-belt stretch and length matching problems . . . reduces costly machine downtime and production slowdowns for individual belt replacement. Sheave ratio and belt position remain constant from *no* load to *full* load . . . assure smooth, *complete* power delivery under the toughest drive conditions. Poly-V Belt can't sink in the grooves under surges of load. This means less wear on belts and sheaves . . . and much more power in the same space as a multiple belt drive—or equal power in much less space!

Just two Poly-V Belt cross-sections meet every heavy duty drive requirement. Let an R/M representative show you how Poly-V Drive can give you greater power-packed performance and drive dependability . . . "More Use per Dollar" than the drive you now use. Write for Bulletin M141.

RM1020

When You Change Drives . . . Convert to R/M Poly-V Drive and Be Sure!

RAYBESTOS-MANHATTAN, INC.

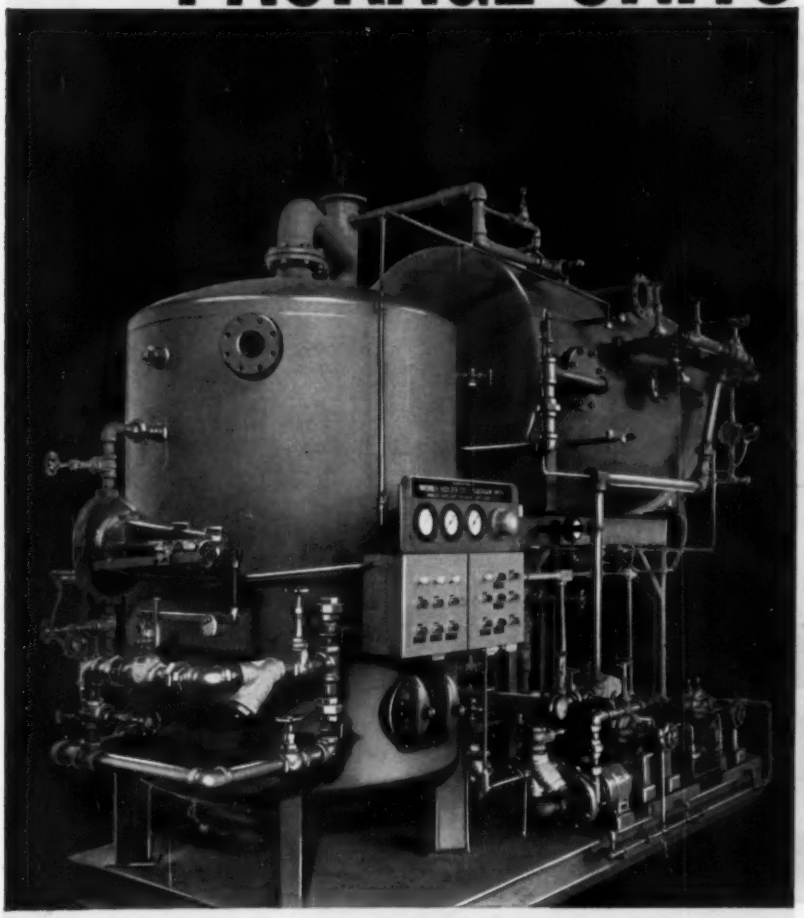
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

ENGINEERED RUBBER PRODUCTS . . . MORE USE PER DOLLAR

Circle No. 109 on Readers' Service Card

WICKES BOILER AUXILIARY PACKAGE UNITS

standard



Save On First Cost • Engineering • Building Space • Construction Time • Operating and Maintenance Cost

Wickes Boiler Co. now offers a packaged system of various compact combinations of DEAERATING FEED WATER HEATERS, BOILER FEED PUMPS, CONDENSATE SURGE TANKS and BLOW-OFF TANKS. Standard units available for steam plants of 10,000 to 100,000 lbs. of steam per hour capacity and steam pressure to 300 PSIG. Information on special units of higher capacities and pressures upon request. Each unit is shop-assembled on a structural steel base, completely piped and wired and equipped with all necessary controls and an instrument panel.

173

Write today for Bulletin 59-1, which gives detailed engineering information on all three models of Wickes Boiler Auxiliary Package Units.

WICKES BOILER CO., SAGINAW 13, MICHIGAN
Division of The Wickes Corporation

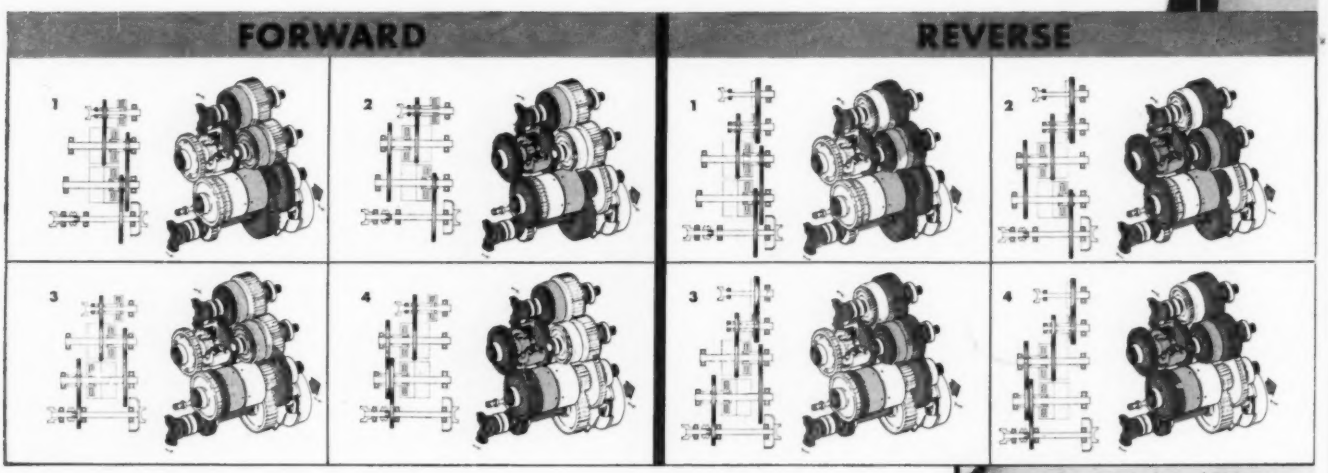
WICKES

RECOGNIZED QUALITY SINCE 1854

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N. Y. • Saginaw • San Francisco • Seattle, Wash. • Springfield, Ill. • Tulsa

Circle No. 136 on Readers' Service Card

4 Speeds Forward...4 Speeds Reverse
FULL POWER SHIFT IN ALL RATIOS



New TWIN DISC TRANSMISSION

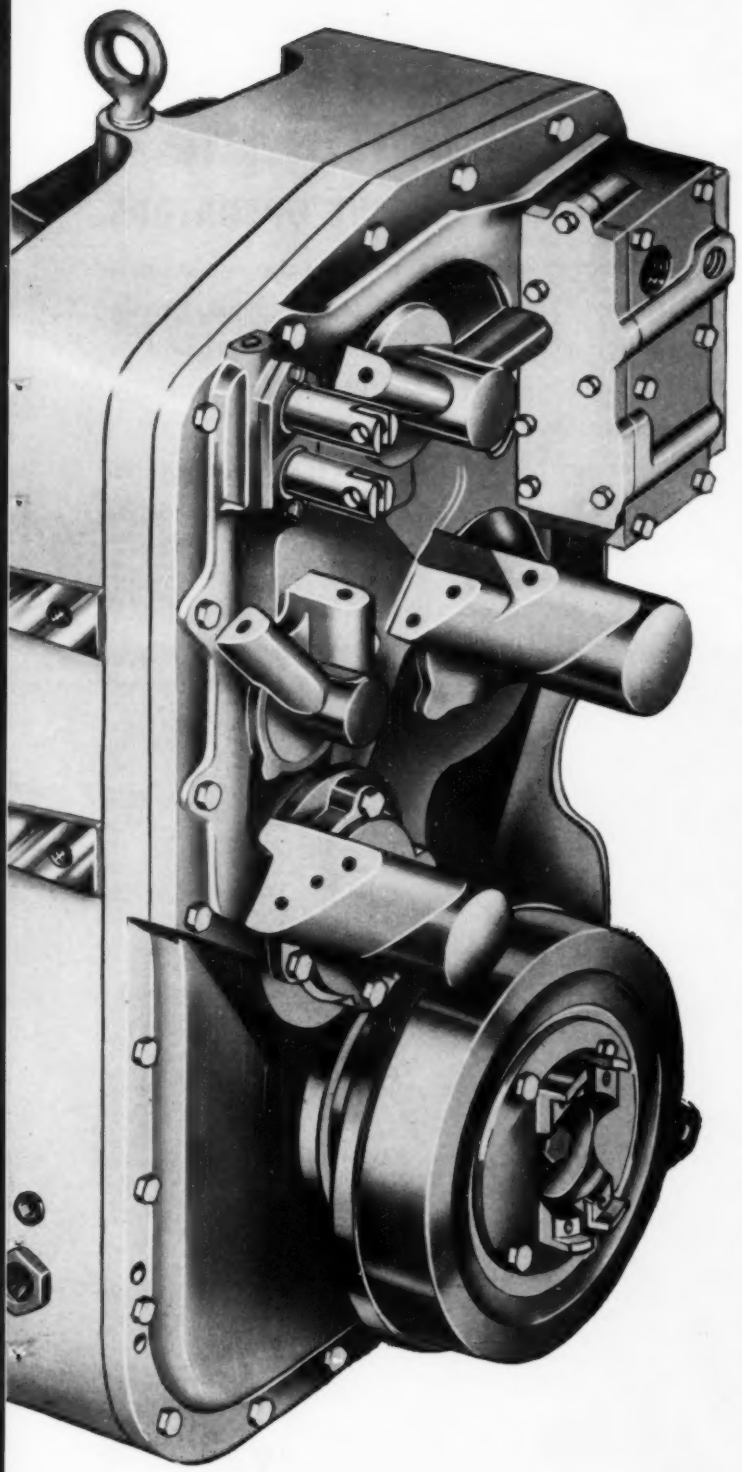
for engines in the 100 hp range

The Twin Disc "engine to axle" concept in OEM power transmission components takes another giant step forward with the introduction of the Series TD-44-400 Power-Shift Transmission. This new Twin Disc design is a four speed forward, four speed reverse box with full power-shifting in all speeds. Designed for engines developing from 75 net hp at 1800 rpm up to 108 net hp at 3000 rpm,* Series TD-44-400 includes two models with an over-all ratio coverage of 6.91:1. Model TD-44-403 has ratios of 4.89, 3.19, 1.08 and .705; Model TD-44-404 has ratios of 5.98, 3.92, 1.32 and .866.

*This is rated horsepower delivery after power is taken off for auxiliary drives.

Simple design, positive operation

The complexities of planetary designs are avoided in the transmission's simple countershaft arrangement. Multiple-disc oil-actuated clutches energize the constant-mesh spur gear trains. The speed changes are effected by two



duplex clutches that function as range clutches.

Two large single clutches handle the direction-changing job. Oil-cooled for maximum heat dissipation, they act as the energizing clutches for all engagements.

Shockless clutching

Clutches are engaged by means of a cascade system of oil pressure regulation. A controlled pressure rise valve increases the pressure steadily and rapidly. This patented feature makes for exceptionally smooth clutch engagement.

The brake-regulated clutch release valve is ported for direct connection to the vehicle's brake fluid system. Thus, by depressing the brake pedal, the operator releases all clutches in the transmission, instantly cutting off the power source for vehicle movement.

Both ends of the output shaft feature yoke-type U-joint connecting members as standard equipment. Also standard is a parking brake and a disconnect jaw clutch on the output shaft. This jaw clutch may be engaged for four wheel drive or disengaged for single axle drive.

Easy servicing

In designing the Series TD-44-400 Transmission, Twin Disc engineers have made easy servicing a prime requisite. Removal of the main housing cover gives complete access to all clutches and range gears. Anti-friction bearings are used throughout. The simple power train and relatively few parts can be readily appreciated when contrasted with the complex power flow and multiplicity of parts in a planetary gear transmission.

Torque converter-transmission package

The TD-44-400 Transmission is normally furnished with a Twin Disc Single-Stage Torque Converter as a package unit. The converter is a sumpless model featuring two power take-off points. One is normally used for power steering. The other incorporates an SAE "C" pump mounting suitable for hydraulic power pumps.

Series TD-44-400 is one of a complete line of converter-transmission packages being developed at Twin Disc's Transmission Division. Twin Disc engineers will be pleased to make recommendations for these units in your vehicle drive. Contact the Transmission Application Engineering Department at our Racine office.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin; *Hydraulic Division,* Rockford, Illinois.

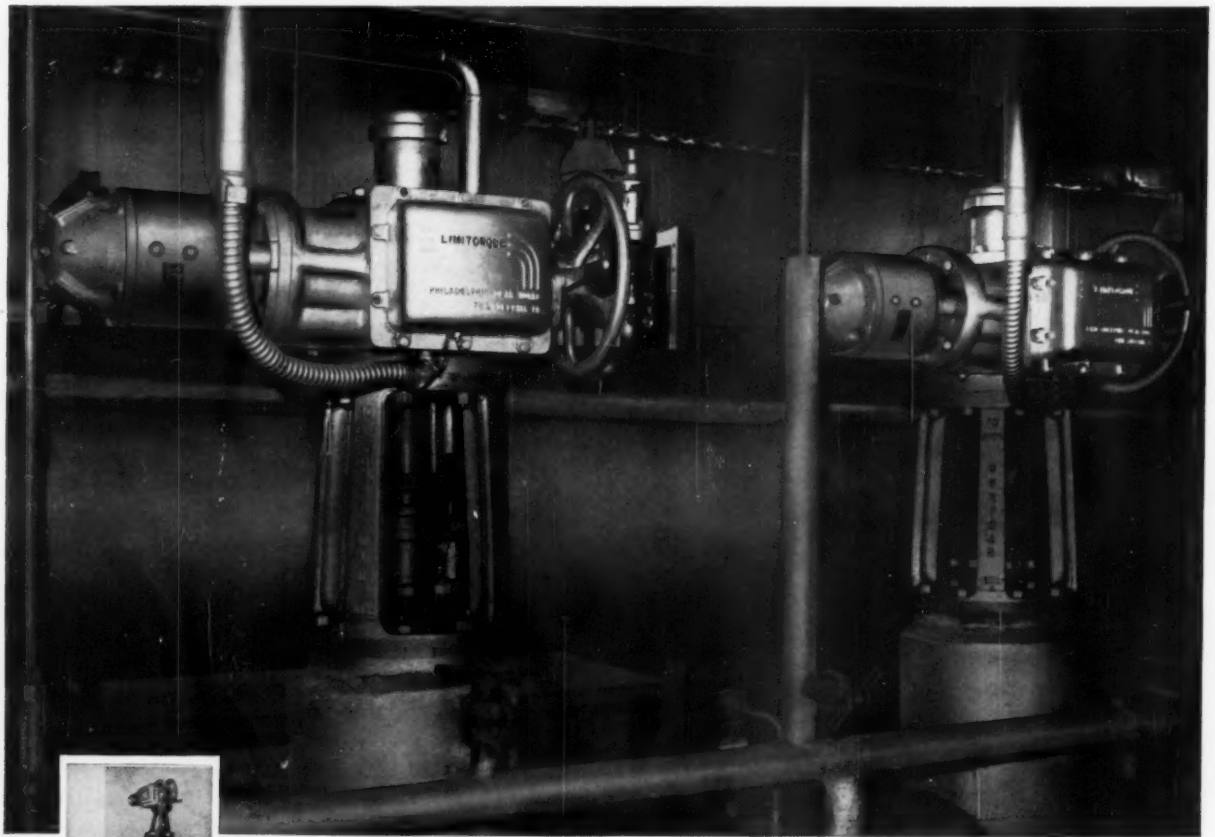
Circle No. 128 on Readers' Service Card

In Eastlake Plant of CLEVELAND ELECTRIC ILLUMINATING CO. — there are many LimiTorque VALVE OPERATORS

The LimiTorque Motorized Valve Operators shown above are mounted on 10" Chapman Gate Valves, operating on boiler feed water line at 3600 p.s.i. . . . one of which is equipped with D.C. motors for emergency operation. Many LimiTorque Operators are used in this modern plant for the operation of valves on various steam and water lines . . . thousands of LimiTorque Operators are in constant use in Power Plants throughout the World.

Wherever automatic, remote valve operation is required, LimiTorque will provide rapid, precise control under a wide range of operating conditions . . . and remember, LimiTorque can be readily mounted on existing valves.

For further information contact your valve manufacturer or your nearest LimiTorque Sales-Engineering Office.



Be sure to send for our complete Catalog L-550 which illustrates and describes the construction, operation, and installation of LIMITORQUE.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • King of Prussia, Penna.

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Quality *costs less* in the long run!

BJ Bilton Pumps

Quality is vital in selecting a small pump too! Without the spares, auxiliaries and regular maintenance schedules most larger installations receive, the small, general-purpose pump often operates under rugged conditions with little or no care.

Backed by Byron Jackson's reputation for quality, the close-coupled Bilton is designed for this kind of service. As a compact motor-pump unit it requires no special base plate, has no shaft alignment problems and can be mounted in any position. Available in capacities from 10 to 2,000 gpm, heads to 520 feet, motors from ⅓ to 60 hp.

Quality is the best investment in the long run!

BYRON JACKSON PUMPS, INC.
SUBSIDIARY OF BORG-WARNER CORPORATION
P.O. Box 70, Lawrenceburg, Indiana
P.O. Box 2017 A, Terminal Annex, Los Angeles 54, California

BW
BORG-WARNER

NEW LX BILTON MODEL brings BJ Quality to the low-cost, low capacity pump market too! Write for bulletin #3-1004.

Circle No. 30 on Readers' Service Card

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

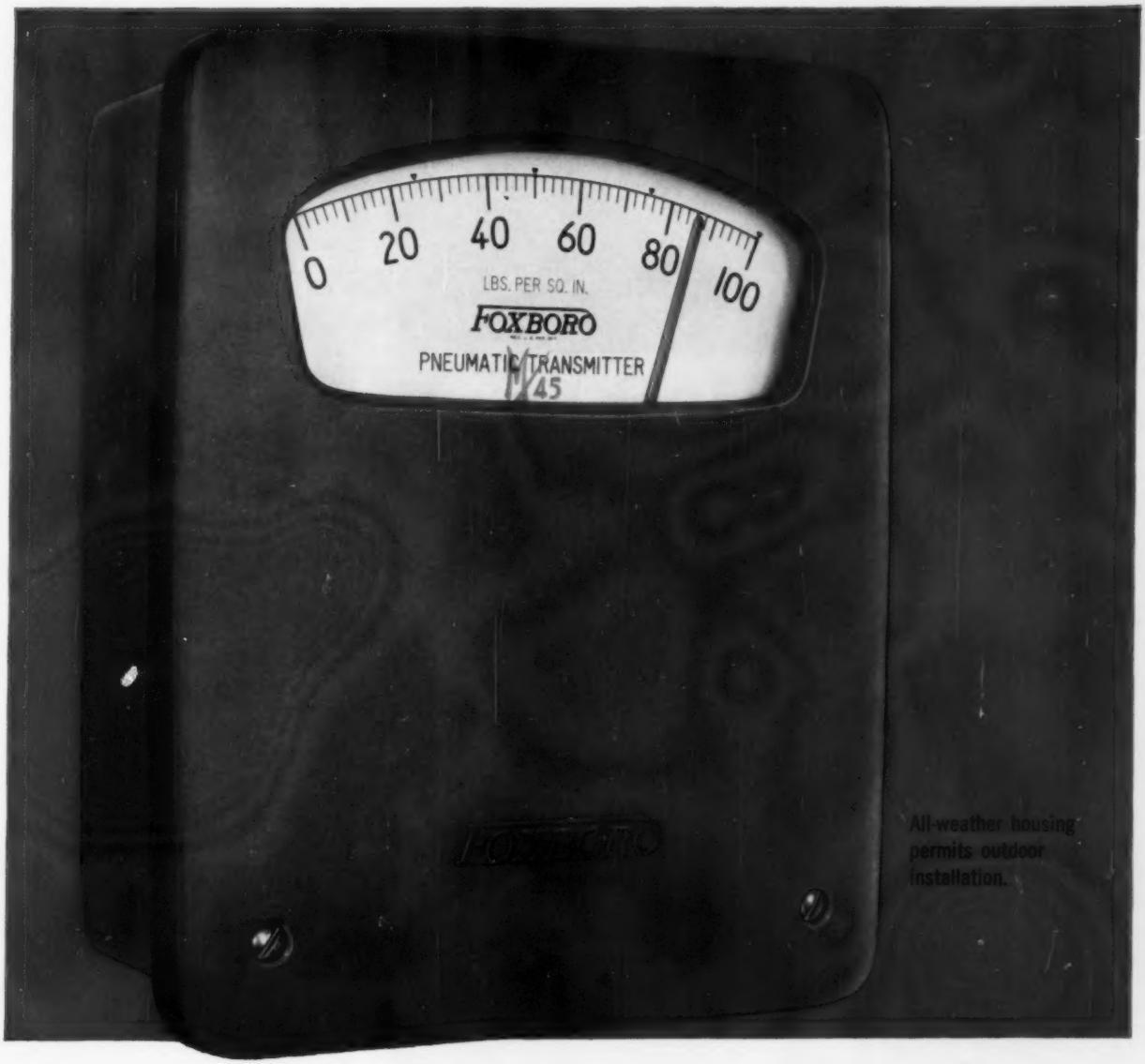
The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

Circle No. 4 on Readers' Service Card

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.



You can use this new Foxboro pneumatic transmitter on six different process measurements

pressure – temperature – liquid level – differential pressure – dew point – flow... all six with guaranteed accuracy of ±½ of 1%

Think of it . . . a universal pneumatic transmitter with matched elements for six different process variables. That's the new Foxboro M/45 pneumatic indicating transmitter.

And with the M/45 you get: *universal* high accuracy-guaranteed at ±½ of 1%; *universal* ambient temperature stability — less than ½ of 1% in 50°F temperature change; *universal* calibration and simplicity of servicing. A remarkable combination of versatility and uniformity in a single instrument.

The new Foxboro M/45 indicating transmitter can extend the benefits of standardization throughout your whole plant operation. Ask your Foxboro field engineer to tell you about it. Or write for Bulletin 13-30. The Foxboro Company, 966 Neponset Ave., Foxboro, Mass.

FOXBORO
REG. U.S. PAT. OFF.

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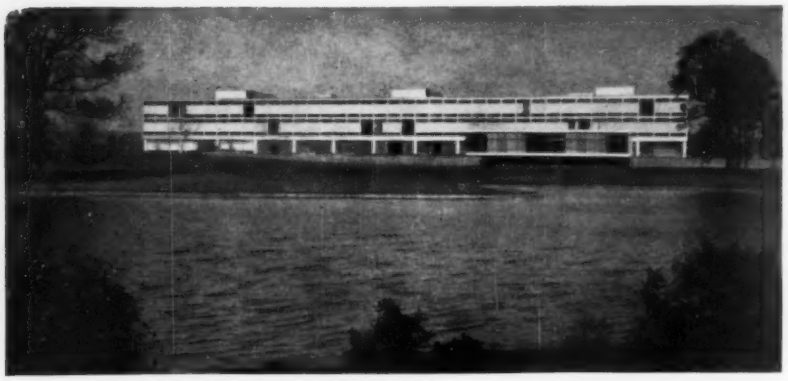
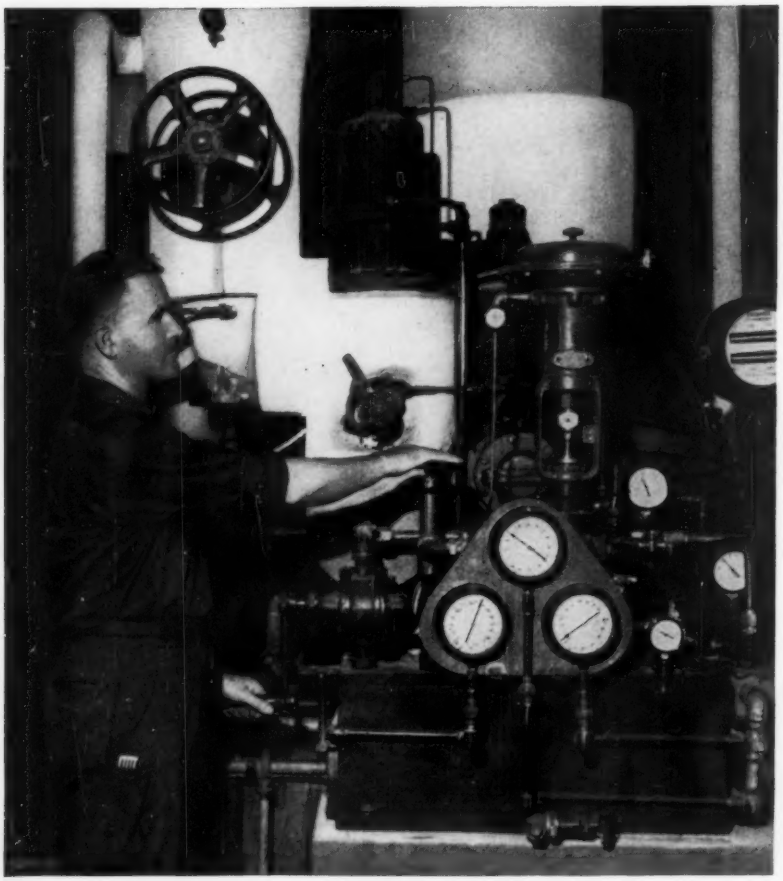


New home office for Connecticut General Life is a modern structure five miles out in the country.

Terry turbines power air-conditioning system at new Connecticut General Life building



One of two 870-hp, 3970-rpm Terry turbines built to drive the refrigeration compressors.

The new home office of the Connecticut General Life Insurance Co., in suburban Hartford, represents the best in contemporary architecture as well as construction techniques and materials.

In keeping with the careful planning evident throughout the project, two Terry turbines were selected to drive the York centrifugal refrigeration compressors. Terry turbines such as these have a record of low maintenance and consistent reliability under varied conditions. The steam generators, which are used for general heating during the winter months, furnish the power to operate the turbines. This provides an economical and dependable air-conditioning setup.

The steel and glass building accommodating 2500 employees overlooks New England farmland. It is furnished with modern equipment, to step up the efficiency of clerical work. Other amenities: lounges, game rooms, cafeteria, bowling alleys, barber and beauty shops, variety store, medical department.

If you are planning an air-conditioning system, perhaps you, too, should consider steam-turbine drive. Write for detailed information about the advantages of turbines for your specific requirements.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1213

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Circle No. 158 on Readers' Service Card

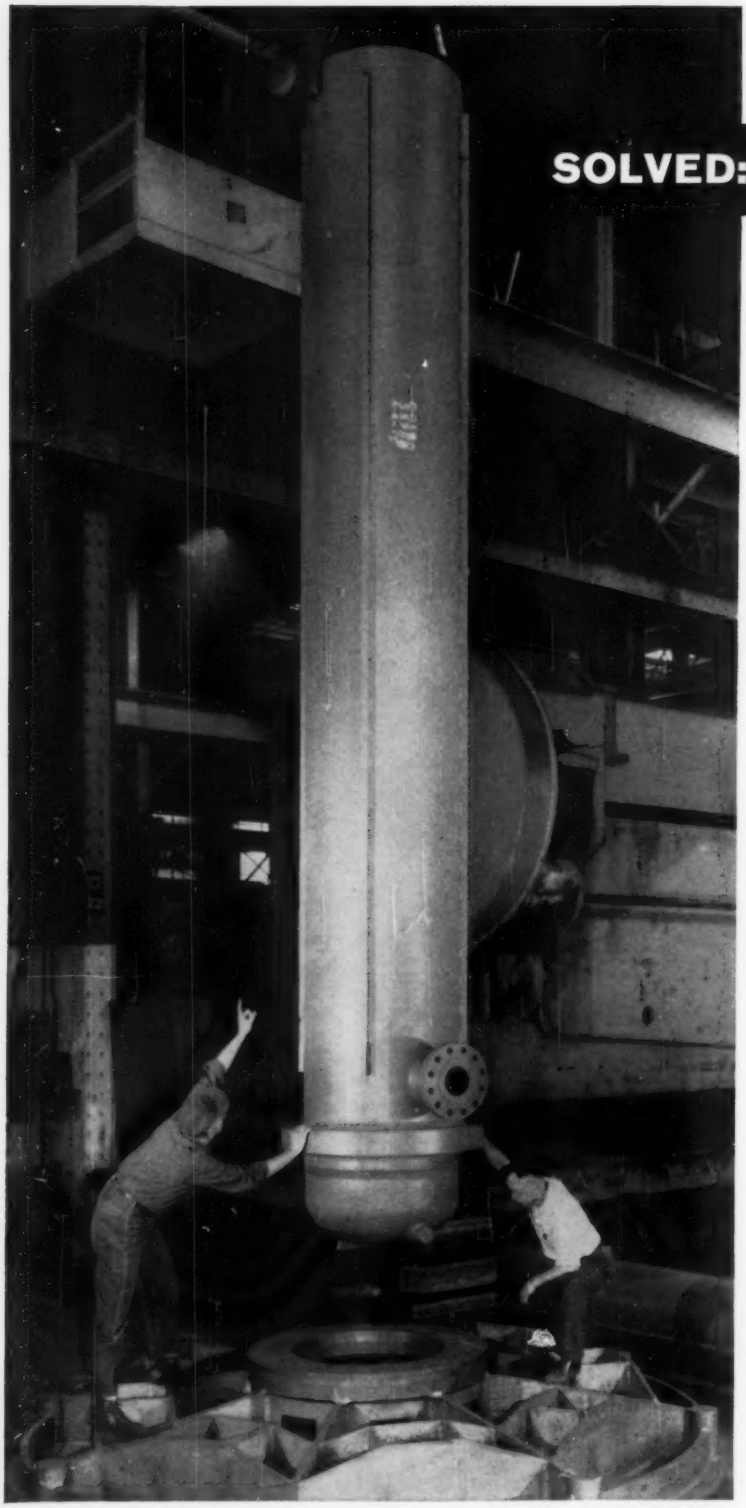
The LGP-30 Electronic Computer begins breaking up figure-work bottlenecks the very same day it is delivered.

The Royal Precision LGP-30 is a complete electronic computer system that is delivered to you ready to go to work. It requires no special personnel. It is simple to program and operate . . . an engineer can use it himself. It requires no air-conditioning or expensive site preparation. In fact, it requires *no* site preparation. Just roll the LGP-30 to where it's needed and plug into the nearest convenient 110-volt AC wall outlet. It's mobile, so it goes anywhere . . . desk-size, so it takes little room.

And, though the LGP-30 can solve routine and theoretical math problems 30x faster than any man—it rents for little more than the salary of an additional engineer. Amazing? No, just well-designed, *advanced*. Let us tell you more about it. Write: Mr. Floyd Ritchie, Royal McBee Corporation, Port Chester, New York.

ROYAL McBEE / GENERAL PRECISION

ELECTRONIC DATA PROCESSING SYSTEMS



Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

SOLVED: by Sandusky Centrifugal Casting

Blaw-Knox chooses 10-ton

SANDUSKY CASTING

for giant slabbing mill

When an 18½-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

This 10-ton carbon steel cylinder, 32" O.D. with a 3½" wall, functions as an accumulator in the mill's hydraulic roll balancing system. Essentially a pressure vessel, it simultaneously supports the ram and ballast weighing 226 tons—the weight required to develop constant operating pressure of 1000 p.s.i.

"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18½ foot length met all our requirements of cost, stability, and strength."*

Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

Write to us at Sandusky, Ohio. Ask for latest Bulletin #200.

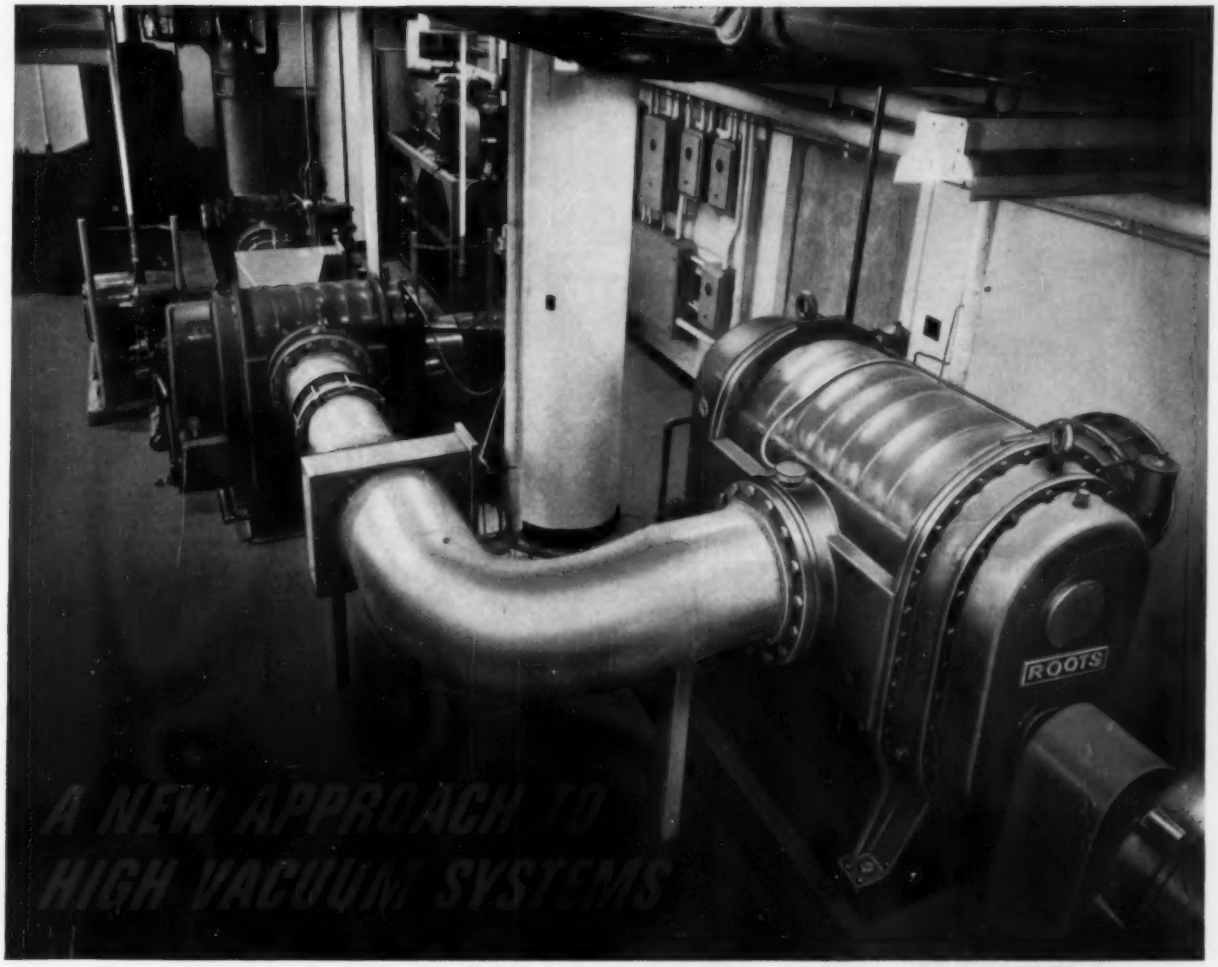
SANDUSKY ® **CENTRIFUGAL CASTINGS**

FOUNDRY & MACHINE CO.

8301

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

Circle No. 116 on Readers' Service Card



Here, three Roots* Boosters are cascaded with a mechanical forepump to simulate altitudes to 155,000 feet (0.92 mm Hg absolute) with an air flow of 1 lb./min., in an environmental test chamber.

Here is a new way to reduce equipment costs and increase efficiency in your high-vacuum processing or environmental system. Roots* Vacuum Boosters are ideal for handling large volumes to 35,000 CFM at absolute pressures as low as one micron.

You save in the number of units required. Select the booster specifically fitted to your requirements; yet, because the Roots Booster has the flattest pumping speed curve of any booster, it is useful over a wider range of operating pressures.

Because operation is practically vibrationless, the booster can be connected directly to the chamber. No valves or by-passes are required in the high-vacuum series; a Roots Booster can windmill in the line until its operating pressure is reached.

Roots Booster operation is efficient, cool, and quiet. Usual operation is at 10-15 compression ratio, and volumetric efficiency is as high as 93%. Vacuum-tight seals proved at a fraction of a micron prevent any leakage, and blank-off pressure is 0.5 micron or lower. There is no bumping or vapor backstreaming, and Roots Boosters easily handle bursts of gas which may result from some processes.

Rugged construction and thorough engineering by the originators of Roots Positive Pressure Blowers assure long, trouble-free life without expensive service interruptions and repairs. Most units are suitable for operation with a differential pressure of more than 7 PSI.

If you need high-vacuum with high throughput in a new or existing system, a single booster or a cascaded system, find out all the advantages of using Roots High-Vacuum Boosters. Forty-five sizes (pumping speeds from 200 CFM to 35,000 CFM) are available. Ask your vacuum equipment supplier or write Roots-Connersville.

ROOTS-CONNERSVILLE BLOWER DIVISION • 900 W. MOUNT ST., CONNERSVILLE, INDIANA
In Canada—Roots-Connersville Blower (Canada), Ltd. • 212 King Street, West, Toronto

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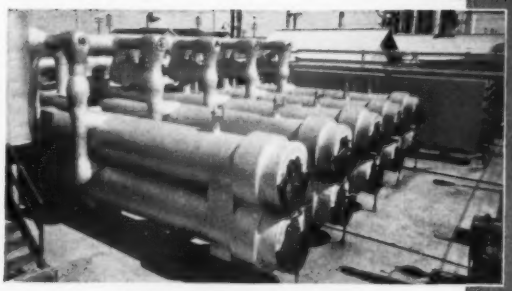

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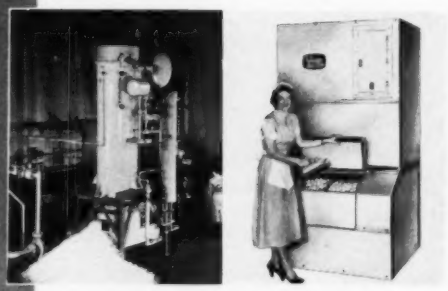

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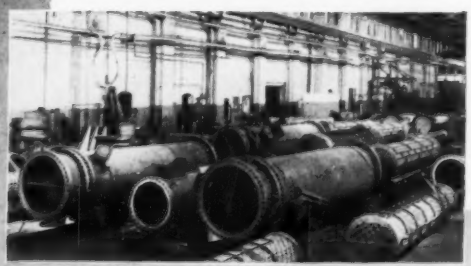

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MECHANICAL ENGINEERING

VOLUME 83 • NUMBER 6 • JUNE 1961

What's in a Name?

How DID the engineer get lost in this "scientific age"?

You and I know that the engineer is the man who makes the miracles happen —takes the scientist's theory and works out the design and the metallurgy; solves the problems of heat transfer and vibration; finds ways to produce the miracle.

Philip Sporn, in the lead article of this issue, states that. . ."the pendulum threatens to swing too far toward science to the detriment of engineering and technology. The idea has become widespread that we must look almost exclusively to science if our society is to continue to progress—that engineering is a minor detail to be resolved easily once the scientist has completed his work.

"The confusion over the distinction between science and technology, and the concept of the scientist that ascribes to him. . .many attractive qualities, have resulted in a tendency to derogate engineering," says Mr. Sporn. "This has affected the choice of careers by a significant portion of our high-school population. It has resulted in a decline in enrollment for engineering training in many of our schools, with an accompanying rise in enrollment in scientific training."

The gravity of this situation was emphasized by William Bergen, president of The Martin Company, when he stated recently that "no deficiency of national resources is so critical as our shortage of technical talent. Not only is the USSR outpacing us, but we are lagging behind ourselves. Our problem is bipolar. One aspect is surely a matter of numbers."

He pointed out that enrollments in engineering schools have been successively declining since 1957. And, based on current demands, it is estimated that, for the next ten years, the country faces annual shortages of some 9000 engineers.

But, says Mr. Bergen, we ought not to allow mere numbers to mislead us into a numerology that endows a large inventory of talent with some kind of hopeful magic. What is more important than the numbers is their potential . . . their technological capability.

Of course, this means a solid educational background. Harking back to the scientist versus engineer dilemma, Dean C. J. Freund, writing in MECHANICAL ENGINEERING, May, 1961, pp. 38–40, called the scientific engineer the hero of the moment. On the other hand the artist or application engineer has been forgotton—and so, to a degree, has his education.

Dean Freund believes it is up to the colleges to educate young men for the artist or application phase of the profession as well as the science phase. To do so is not fashionable at the moment. Dean Freund doesn't propose to relax the present emphasis on engineering sciences in the colleges, and to substitute emphasis on application. The colleges must provide both. Most important, they must give equal recognition and status to both the scientific and the application engineer.

The sooner this is accomplished the sooner will the application engineer take a recognized place in society. Of course, many of our so-called scientists are, in fact, engineers who have wandered over to this gray area of scientific-engineering. A place also must be reserved for these engineers who concentrate on scientific research.

Both are vital to our growing economy. But it is hoped that what may be only a play on words—scientist-engineers, engineers, scientists—may indeed be clarified with more suitable nomenclature. Needed: Better identification for engineers.—*J. J Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

THE CASE

By Philip Sporn, Hon. Mem. ASME, President, American Electric Power Company, Inc., New York, N. Y.

A penetrating look at the place of science and technology in our society, and engineers for the world of tomorrow. Can the engineer, as now trained, play

For perhaps too long a time, basic scientific research was, if not neglected, at least de-emphasized, but we now appear to be in danger of overcorrection. The pendulum threatens to swing too far toward science to the detriment of engineering and technology. The idea has become widespread that we must look almost exclusively to science if our society is to continue to progress—that engineering is a minor detail to be resolved easily once the scientist has completed his work.

The fact is, that there has been no revolutionary change in the relationship between science and technology. It has been a fruitful relationship going back as much as 100 years. The development from Faraday's scientific experimentation to modern electric power technology is one of its earliest, and perhaps best, exemplifications.

Applied Science

In their simplest concept, technology and engineering are applied science. But technology is really a great deal more than this. It embraces all human experience with science, tools, methods, systems, and organization that add leverage to man's effort and make possible much greater abundance than his unaided physical strength and skill alone could deliver.

Despite the close bond between science and technology, perhaps even because of it, there has developed a serious misunderstanding about the respective roles of science and technology that persists at almost all levels of our society. It has had an impact on education and educational programs and could have a severe, adverse effect on our ability to cope with the difficult problems confronting our society and our future as a nation; it could adversely influence our security and our defense, and the defense and the survival of the whole West.

This misunderstanding has become pervasive throughout our whole society—laymen, high-school students, faculty and counselors, technical-college students and faculty, and even among the scientists themselves.

Even such a distinguished student and analyst of science and scientists as Sir Charles P. Snow ascribes to scientists the exclusive possession of powers and skills which they simply do not possess. When Sir Charles says he wants "scientists active in all the levels of government" because they are trained in foresight, or that "scientists have it within them to know what a future-directed society feels like," or again that scientists "have been in certain respects just perceptibly more morally admirable than most other groups of intelligent men," he is ascribing qualities to scientists that are either totally absent in many cases or, if they exist, certainly do so to no greater degree than among other members of our society. And this type of glorification of the scientist, with the accompanying, if subtle, downgrading of the engineer, has resulted in a great deal of damage.

A False Belief

And the scientists are not the only ones who have made claims for science that would be difficult to demonstrate. When the scholarly president of one of our great mid-western universities says he believes "that science today has the magnificent power of creating conditions that will allow man, for the first time in recorded history, to master the created universe in such a way that human dignity can rise above the miserable conditions that reduce man to little better than an animal," he is claiming for science more than it can achieve alone.

Far-Reaching Damage

The confusion over the distinction between science and technology, and the concept of the scientist that ascribes to him these many attractive qualities, have resulted in a tendency to derogate engineering. This has affected the choice of careers by a significant portion of our high-school population. It has resulted in a decline in enrollment for engineering training in many of our schools, with an accompanying rise in enrollment in scientific training.

This is cause for concern because, if the present trend continues, our rapid rate of technological development may be seriously impaired.

Condensed from an address delivered at the Special Convocation of Technion, Israel Institute of Technology, held at the Carnegie Endowment International Center, New York, N. Y., March 8, 1961.

FOR THE ENGINEER

the related problem of training his hoped-for role in history?

I will cite three currently exciting technological developments erroneously thought to require additional efforts of science rather than of engineering—one in an advanced stage of development, one moderately advanced, the third in an early stage—and discuss the kinds of problems remaining to be solved before they reach fruition.

Atomic Energy

Consider, first, atomic energy. Many of those who made such significant contributions to the Manhattan District Project continued their work in atomic energy after the war. It was their scientists' viewpoint that dominated the early postwar development of atomic power generation. The result was a misdirection of effort and an induction of false hopes because of the failure to appreciate the problems of technological, as distinguished from scientific, development.

The scientific basis for the nuclear generation of electric energy was fully, or at least adequately, known but the difficulties to be overcome in the engineering implementation were overlooked. In particular, the economic factors were not properly evaluated, and it was not adequately understood that the conventional fuel technology was in a phase of dynamic change which presented a moving target, so to speak. Even more, there was a failure to recognize that progress in nuclear-power technology could best be obtained by building upon the existing and highly advanced power technology.

The fact that we are today quite well advanced along the road of making atomic energy competitive in the high-cost-energy areas of the U.S. is due to our concentrating on the engineering aspects rather than the scientific aspects. Costs, questions of arrangement, questions of size, the problems of heat transfer, the problems of pressure suppression in case of rupture, the problems of metallurgy both within and without the reactor, the problems of thermodynamic heat balance—all are now being given the consideration they require. Much time was lost, however, before it was recognized from which partner of the science-technology team the real contribution was needed.

The Case of Sea-Water Conversion

Consider the case of sea-water conversion, a problem particularly acute in Israel but not an insignificant problem in some parts of the U.S. The basic science of getting the salt out of sea water is as old as recorded history. Julius Caesar and the ancient Phoenicians had already found the secret—just distill it. But the economic application is a totally different affair.

We have made great strides in resolving these problems: In applying lower-cost materials to improved designs; in advancing the terminal temperatures of operation; in reducing scale and corrosion; and in seeking lower-cost sources of energy, either through independent approaches or through intergration with other more advanced technologies, such as power generation. This progress has been achieved only during the past decade or so, when necessity once more became mother to invention—engineering invention. Through the development of multistage flash evaporators we have seen the utilization of heat energy increased tenfold and more, with costs so materially reduced that, in a yet small but increasing measure, converted water is already competing with the ever more costly natural supplies.

The time scale for broader application of water conversion will be reduced not by any spectacular scientific breakthrough or innovation, but rather by the development and application of continued small advances in chemical and thermodynamic engineering.

MHD

Magnetohydrodynamics is another intriguing field where engineering solutions are required to put to useful work long-known and understood scientific principles.

More than 100 years ago, Michael Faraday demonstrated that, if a conductor moves through a magnetic field, current is caused to flow in the conductor circuit. In addition to copper conductors, he also investigated a moving fluid, namely, the River Thames, as a conductor moving through the earth's magnetic field. Because of poor conductivity of the water and the weak magnetic field, no current flow was recorded. But nonetheless, Faraday had conceived the MHD generator.

THE CASE

Recent work in our space program has provided us with the necessary understanding of the conductivity of gases at high temperatures, so that now we can describe, theoretically but accurately, the performance of an MHD generator. The phenomena involved are understood. Engineering problems must now be attacked and solved. High-strength and economical magnetic fields must be designed. This has required the introduction of the scientifically demonstrated but far-from-engineered concepts of cryogenics and superconductivity. Walls must be designed to contain gases at 5000 F or higher.

Education Strives to Keep Up

In the face of a developing need for more and better-trained engineers, so well exemplified by the three technological developments just discussed, our educational institutions have been striving conscientiously to meet their responsibilities. Generally, they have been increasing their emphasis on mathematics and on science. In many cases they have been allotting time, or have increased their already allotted time, to the humanities.

In too many cases they have considered they were almost completely bound by historical and rigid precedent as to student time availability. The tradition of graduating a salable product in a particular engineering specialty, and within a limited time, is a strong one. The net effect of this has been, on the whole, a sharpening or narrowing of the field of vision of many of our graduating engineers.

Is it not pertinent to ask how well equipped are the products of such training to solve the engineering problems of the world of tomorrow? If we are looking for people who can take an integrated view of a problem and can place it in its broad social, political, and economic as well as technical context, then it seems to me that the situation with regard to the adequacy of curriculums and of faculty is in most cases not so good.

There are too few places where engineering students are given an opportunity to acquire a firm background in the liberal arts—in history, the history of science and technology, in economics, and political economy, the dynamics of political and social-economic history, and in philosophical and cultural values. Nor are there many places where the attempt is made even to stimulate at least the awareness among engineering students of the importance of integrating these materials into their career activities.

The engineer ultimately is not going to be judged by whether his machinery rotates at a constant speed or a variable speed, or whether the temperatures of his metals are at 1100, 1200, or 1300 F, or whether his unit stresses are 20, 50, or 100,000 psi. The judgment of society will be based on how the complex he creates functions in society—what it does for society.

The World of 1985

Our colleges need to comprehend the idea that the 1960–1965 student body will not make the world of 1965, but will have the responsibility for creating the world of 1985. It is for this they must be trained. The colleges and universities not only must never surrender their responsibilities nor their historic tradition of being leaders of thought; they must also remember that they are educating men who will be leaders in thought.

All our engineering schools are weak because of the inadequacy of the student body. We just do not get a large enough share of our talented youth. We must find some way to attract more of our young people into engineering schools, and we need to do a great deal of what I can best describe as beneficiation before we bring this talent into our engineering schools. This requires a reorientation of both the character and the tempo of training in our high schools and preparatory schools. We need to do a better job of finding and selecting the material that results from that beneficiation.

The Curriculum—Deeper and Broader

The curriculums need to be deepened and broadened. The student needs to be given at least a start toward understanding the world he is going to work in, the world he will try to improve, and the world he may have the job of running. Since he is going to be called upon to reach decisions that may have far-reaching effects on society, not only must he be capable of crossing traditional dividing lines in engineering, but he must develop a deep understanding of the social-economic forces at work in the world.

No engineer, for example, should go out into the world without solid grounding in geography and oceanography; or in meteorology, geology, and hydrology. And surely he cannot do without a knowledge of engineering materials, structural chemistry, or energy sources and energy conversion systems. We need to look at the problem of engineering training in terms of a time period that extends well beyond the demands of the moment.

Students need to have a great deal of contact with industry. I have seen a number of the co-operative programs operated by our engineering colleges, but I do not believe they are widespread enough. We need more. They bring students into contact with engineers at an early phase of their careers, and this is to the good.

Inspiration From the Faculty

We need to do something about faculties. Students of engineering need to be inspired to climb to the heights of engineering: They ought to be exposed to at least a few great engineers. Certainly many of our great surgeons were inspired by studying under the guidance of other great surgeons. We do not have that; at least we do not have enough of it. This can be rectified by bringing practicing engineers into our engineering faculties. There is a good technique for this—the adjunct professorship.

If we succeed in doing these things, then we will have trained and produced the engineers we must have if we are to solve the difficult national and world problems confronting us today and, to an even greater degree, tomorrow.

Our modern technology and our social organization founded on that technology have the unique capacity to create material benefits in abundance for the population as a whole. Only by maintaining a proper balance between science and engineering can this progress be continued. With material needs provided for, we may then hope that man may, as never before, be able to devote his energy to the spiritual enrichment of his life.

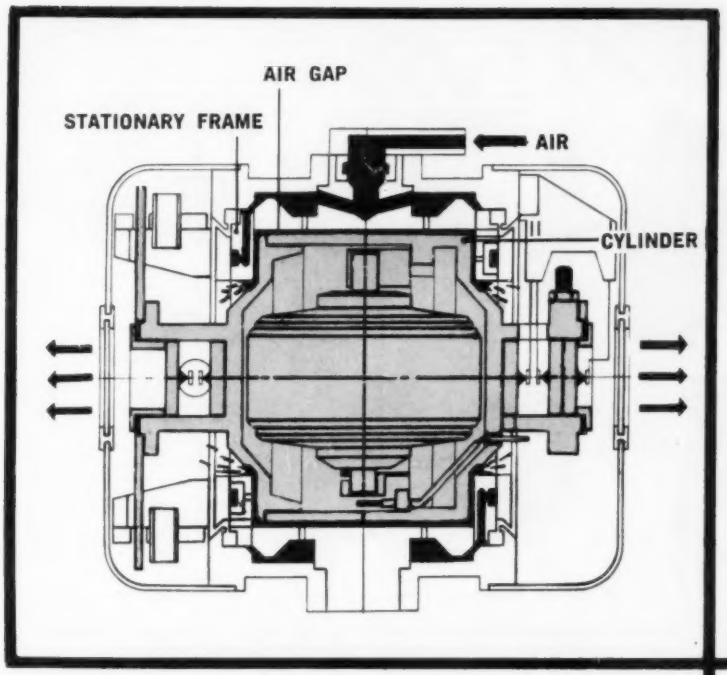


Fig. 1 Cross section of an air-bearing gyroscope. The high-speed gyro motor is encased in a gas-supported cylinder (shown in gray). Air or nitrogen (shown in black) enters a gas chamber. Small nozzles lead to the gap in the axial and radial direction. The gas escapes from the gap around the necks and edges of the cylinder. Number of nozzles varies with the size of the bearing.

Accuracy dictated the use of pressurized gas bearings in the navigational instruments of the Army's ballistics missiles. Here are the factors involved, the test methods employed.

EXTERNALLY PRESSURIZED GAS BEARINGS

By H. C. Rothe, Director, Astro-Space Laboratories, Huntsville, Ala.

In the enthusiasm attending the great revival in interest in gas bearings during the past few years there has been a tendency to overlook their limits and disadvantages as compared to conventional bearings. It is worth emphasizing that a gas bearing is a very specialized instrument, which will never replace ball or journal bearings in general applications. Nevertheless, there are some fields in which either pressurized or self-acting gas-lubricated bearings have established or will establish themselves as useful members of the bearing family.

The foreseeable fields of application are: (*a*) For extreme-temperature environments, (*b*) for areas where oil or grease cannot be used because of explosion or radiation problems, (*c*) for instruments with high rotational speed and long life requirements as anticipated in space vehicles, (*d*) for high load or high speed, where a change in the bearing characteristics during operation cannot be tolerated, (*e*) for negligible rotational or translatory speed, but extremely low friction.

Contributed by the Lubrication Division and presented at the Lubrication Symposium, Miami, Fla., May 8–9, 1961, of The American Society of Mechanical Engineers. Paper No. 61—LubS-4.

Advantages and Limitations

The favorable parameters of gas bearings can be surmised from the list of applications. They are: (*a*) Insensitiveness to environmental temperature conditions, (*b*) the absence of conventional lubricants and their attendant chemical or radiation-reaction problems, (*c*) absence of coulomb friction, resulting in unlimited life expectancy, coupled with stable performance characteristics, (*d*) extremely low friction level for low rotational or translatory speed.

In considering their disadvantages it is necessary to discuss the two types of gas bearings separately.

The self-acting bearing provides a film of air between the moving parts by the relative speed of these parts against each other. A fairly stable environmental pressure is required, but no special gas supply. The dry starts and stops, rather than the actual running time, determine the lifetime of these bearings and make the employment of special materials necessary. For load-efficiency reasons, a very small gap—100 millionths of an inch or less—must be used between the moving parts. This requires excellent surface finish and extremely low manufacturing tolerances.

EXTERNALLY PRESSURIZED GAS BEARINGS

Fig. 2 Cross section of a restriction nozzle. Holes of about 0.02 in. in diam are drilled in the sleeve and the thrust plates and 0.002-in-thick aluminum foil is cemented over the hole. This is dimpled by a small ball and pierced with a 0.005-in-diam pointed steel needle.

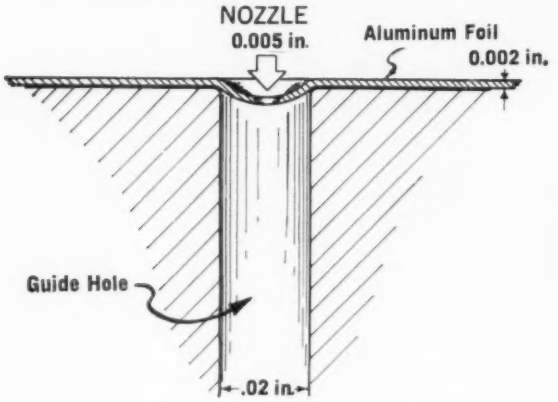


Fig. 4 The load capability of the bearing for constant acceleration in each of its principal axes is determined with a centrifuge. The bearing is used as a capacitor in an 800-cps circuit to indicate the touch point correctly. The supply pressure which just floats the bearing is found for several g-loads.

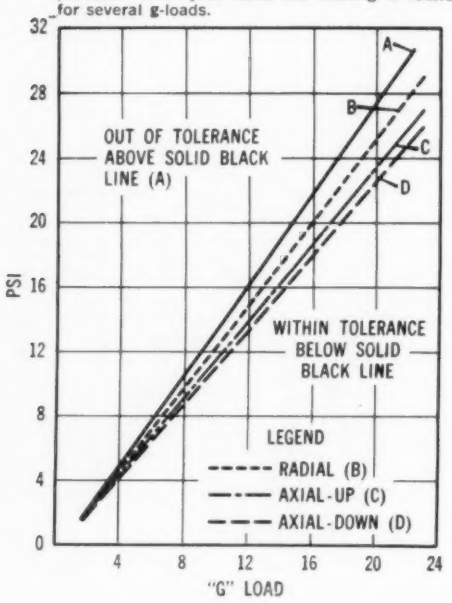
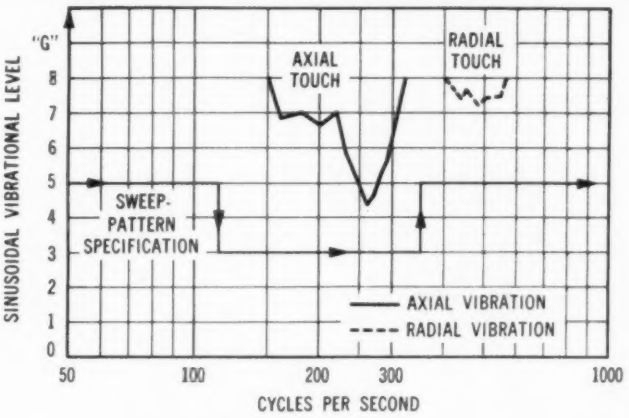


Fig. 5 Response of the air bearing to sinusoidal vibration. Tests for vibrational accelerations are performed on a shake table whereby the gas pressure is kept constant at the operational value. Limits of g-load are plotted against vibrational frequency.



At high speed, the narrow gap produces shear forces of a magnitude such that the torque is comparable to that produced by ball bearings. Another inherent shortcoming of this type of gas bearing, when used for radial load, is the angle produced between the direction of the yield and the direction of the load. In gyro applications, this phenomenon affects the accuracy in a manner very similar to that of the nonisoelasticity error.

Another problem is stability. Several kinds of instability occur or tend to occur at different rpm. More research must be done to gain better understanding of this very troublesome area.

The externally pressurized gas bearing, on the other hand, requires a constant gas supply in the form of a storage tank or a pump system. Filters must be used to insure the cleanliness of the gas. While the gap on this type of bearing is several times wider than on the self-acting one, the low-turbine-torque requirement demands very close manufacturing tolerances to insure symmetrical gas flow inside the bearing. Again, instability—introduced here by the gas-feeding system—is a problem.

Pressurized-Gas-Bearing Applications

Accuracy was the primary determinant in the decision to use pressurized gas bearings in the navigation instruments of the Army's ballistic missiles. The accuracy of a gyro is determined by the torque acting about its inner gimbal axis, since the drift rate is directly proportional to this torque.

A simple equation, $\omega = T/A$, gives the torque level which can be tolerated.

In it ω equals the drift rate in radians per sec, T equals the torque in dyne-cm, and A equals the angular momentum of the gyro in gram cm^2 per sec.

The required drift rate for today's precision gyros is a fraction of a degree per hour. If a gyro of medium size is assumed with an angular momentum of 2 times 10^6 gr cm^2 per sec, the equation yields a tolerable torque of 1 dyne-cm for a drift rate of $^1/_{10}$ deg per hr. This torque level is several magnitudes lower than that which any conventional bearing can supply. The inner gimbal axis has negligible angular speed; therefore, when using a gas bearing, it has to be externally pressurized.

Fig. 3 Exploded view of a gas-bearing gyroscope. Behind the opened can with the gyro motor, **front row**, lie the sleeve, the thrustplates, and the covers for the air chamber. **On the right side** are arranged the current transfer, the torquer, the pickup, and the dust cover.

Fig. 6 Stiffness is determined by recording the position of the float as a load function in the axial static-load test

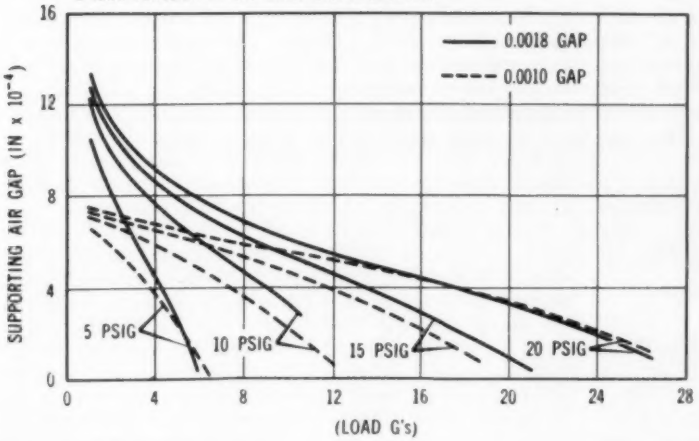
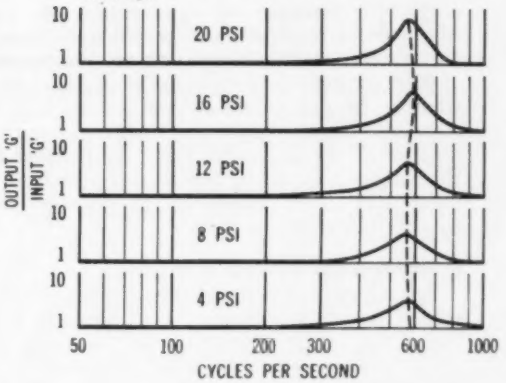


Fig. 7 The influence of supply pressure, size of air gap and nozzle, and number of nozzles is investigated in stability tests. g ratio is recorded for vibrational excitation perpendicular to the axis. The vibrational acceleration g is kept constant while the frequency changes from zero to 1000 cps.



Design and Physical Principle

A schematic cross section of an air-bearing gyroscope is shown in Fig. 1. The high-speed gyro motor is encased in a gas-supported cylinder. Air or nitrogen enters the gas chamber through a filter. From this chamber, small nozzles lead to the gap in the axial and radial direction. The gas escapes from the gap around the necks and the edges of the cylinder. The number of nozzles varies with the size of the bearing. There are two or four rows of nozzles in the sleeve with eight to 24 nozzles per row and six to 12 nozzles in each thrustplate.

A cross section of a nozzle is shown in Fig. 2. Holes of about 0.02 in. in diam are drilled in the sleeve and the thrust plates. A piece of aluminum foil 0.002 in. thick is cemented over the hole. This foil is then dimpled by a small ball and pierced with a pointed steel needle of about 0.005 in. in diam. This elaborate procedure is used to insure the uniform gas flow through the nozzles which is necessary for low turbine torques.

Actual hardware is shown in Fig. 3 in an exploded view. In front row is the opened can with the gyro motor. Behind it lie the sleeve, the thrustplates, and the covers for the air chamber. On the right side are arranged the current transfer, the torquer, the pickup, and the dust cover. Bearings of this type are manufactured in several sizes from 1 to 4-in. float diameter. The ratio between length and diameter of the float is equal to approximately one on all bearings.

The following approach proved to be useful as a start in the design. The intended application determines the size of the gyro motor required. The float is designed to fit this gyro as a housing. This establishes the weight and the projected area of the float. Weight multiplied by highest anticipated linear acceleration g and divided by the projected area results in the necessary mean pressure difference. This pressure is divided by 0.6 to find the approximate supply pressure required to prevent the bearing surfaces from touching at the highest rate of acceleration. This ratio, 0.6, may be called a load-efficiency number. It was established by measurements on several hundred bearings of this design. The actual supply pressure varies from 15 to 27 psi for different

EXTERNALLY PRESSURIZED GAS BEARINGS

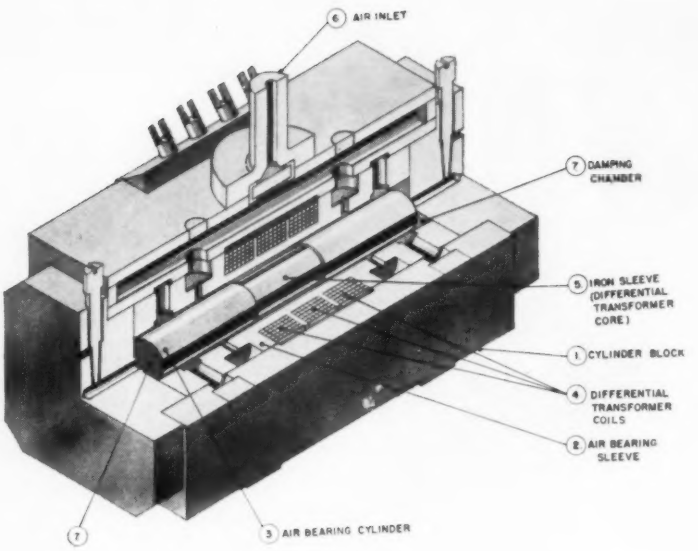


Fig. 8 An air-bearing pendulum which is used on stabilized platforms to establish the local vertical with great accuracy. A horizontal ceramic slug (3) takes the place of the well-known swinging weight. It is radially supported by air and carries an iron sleeve (5). A differential transformer (4) on the sleeve picks up the axial position of the slug. Damping chambers on both ends (7) permit adjustment of the pendulum time constant for different applications of this instrument.

applications. The air consumption at the operational pressure lies between 0.5 and 2 standard cu ft per min.

The underlying physical principle of this type of bearing can be explained very simply. Gas flow through the nozzles is constant and sustained by the exterior gas supply. An originally centered float will move to one side under load and consequently will restrict the amount of flow through the nozzles on that side. On the opposite side, the gap widens and the flow through the nozzles increases. Since the pressure drop inside each nozzle is a function of the amount of flow, the pressure increases in the smaller gap on the loaded side and decreases on the other side. The differences in pressure establish an equilibrium with the load.

Pressurized Gas Bearings in Missiles

For missile application, the performance requirements which have to be met are: (*a*) Compatible load-carrying capability in all directions, (*b*) assurance of stability under extreme environmental conditions including vibrations, load variations from zero to maximum, and ambient-pressure fluctuations, whereby the turbine torque should not increase substantially.

To insure performance under missile conditions, the following test methods are used:

Load Capability. A centrifuge is used to determine the load capability of the bearing for constant acceleration in each of its principal axes. The bearing is used as a capacitor in an 800-cps circuit to indicate the touch point correctly. The supply pressure which just floats the bearing is found for several *g*-loads, Fig. 4. These tests are repeated under different ambient-pressure environments. The tests for vibrational accelerations are performed on a shake table with the gas pressure kept constant at the operational value. The limits of the *g*-load are plotted against vibrational frequency, Fig. 5. Another test determines the stiffness by recording the position of the float as a load function. An example for different pressures and for two different air-gap sizes is in Fig. 6.

Stability. Many tests are made to determine the stability of the bearing. The influence of supply pressure, size of air gap and nozzle, and number of nozzles is investigated. The bearing is vibrated consecutively in its axial and radial directions and 45 deg to both axes. The vibrational acceleration *g* is kept constant while the frequency changes from zero to 1000 cps. An acceleration pickup is mounted on the float and the ratio between input and output *g* is recorded, Fig. 7.

Pressure Distribution. For this test a dummy float is inserted in the sleeve. This float is equipped with a row of holes, each one connected to a pressure meter. The float is slowly rotated and the pressure distribution in the air gap is recorded under different load conditions.

Turbine Torque. Torque levels of one dyne-cm and less prohibit the use of conventional torque-measuring devices. It was found that the method of measuring the angular acceleration of the float gave satisfactory results. To insure that the bearing is really free floating, it is placed with its axis in a horizontal position and an unbalance weight is attached to the float. An angular displacement is given to the float and the decaying oscillation angle is timed. The angle versus time is plotted on semilogarithmic paper; a free-floating bearing will produce a straight line. The bearing is then balanced again and mounted on a turntable. A pickup between float and sleeve is used in conjunction with an amplifier and drives the servomotor of the turntable, thus maintaining the sleeve in a fixed position to the float. The acceleration of the turntable multiplied by the moment of inertia of the float equals the torque at this particular float position with respect to the sleeve. In this way the viscous damping inside the bearing has no influence upon the measurement.

Another application of the pressurized air bearing is for an air-bearing pendulum which is used on stabilized platforms to establish the local vertical with great accuracy, Fig. 8.

In this configuration, a ceramic slug is radially supported by air and carries an iron sleeve. A differential transformer on the sleeve picks up the axial position of the slug. Damping chambers on both ends of the slug permit adjustment of the time-constant of this instrument for different applications. This instrument has also been produced and used in large numbers for many years.

Who would have believed that the 1960's would find us struggling to estabish basic theory in some departments of metalworking? New hard-to-work materials demand deeper understanding. This is an index to the past year's developments.

Metal-Processing Literature

METAL CUTTING ANALYSIS

By J. S. Campbell,[1] S. Kobayashi,[2] J. M. Galimberti,[3] Robert S. Hahn,[4] and E. G. Thomsen[5]

SEVERAL noteworthy reviews and analyses of the state of knowledge of metal cutting appeared recently. These should be of general interest to those associated with metal-cutting research and development. Nowikowski and Koster [1][6] reviewed the literature for the Air Force in order to collect knowledge on machining characteristics of high-strength and thermal-resistant materials. A research report for ASTME [2], which listed 381 references and gave a wide coverage of subject matter, made a plea not only for the continuance of research for the improvement of practice, but also for greater emphasis on theoretical work. Merchant [3] discusses the challenge before us of the problem of cutting materials which are difficult to machine. This author suggests that an effective research program is one in which basic and applied research are carried out together. He then describes the type of research that is carried out at Cincinnati Milling Machine Co.

Two other reviews of interest are those by Rapatz and Motalik [4] and by Opitz [5]. These reviews are written in German and appear to concentrate on research work in Germany. While Rapatz and Motalik discuss the general state of knowledge, Opitz concentrates mainly on wear and tool life and lists 59 references. Opitz attributes the greater cratering of carbon steels as compared with alloy steels at the same strength level as being mainly due to the transformation of the microstructure of the chip to austenite. Hitomi [6] reports on research on machinability in Japan, covering a number of subjects, such as indentation of cutting tool, friction process, plastic-flow concepts, tool-chip contact area, and others, listing 38 references. Finally, a treatise on machining of ferrous metals [7] appeared in German, which covers a number of aspects of machining.

Mechanics of Chip Formation

Judging by the number of papers, the mechanics of chip formation is still one of the challenging problems in metal-cutting analysis. Okushima and Hitomi [8] propose that the metal-cutting zone is not a narrow band but rather a region given in the shape of a wedge of metal between the tool point and work and chip surfaces. Inasmuch as the tests were carried out with lead

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The members of the Literature Review Committee of the Metal Processing Research Activity of ASME are:

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F. W. Boulger, Battelle Memorial Institute—Plastic Working of Metals.
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[6] Numbers in brackets designate References at end of each section.

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at low cutting speeds of 0.01 fpm, it is questionable whether the analysis can be extrapolated to steels machined at conventional speeds. Colding [9, 10] advances a new formula for determining the angle relationship in metal cutting. He shows that the divergence of experimental results from the Lee and Shaffer solution can be explained by anisotropy of the work metal. No method is offered by which to evaluate the parameters characterizing the anisotropy, nor are metal-cutting data correlated with the properties of the work material. Chang and Heginbotham [11] attempted to correlate static and dynamic shearing stresses with metal-cutting data. They found no agreement, apparently because of the fact that comparison was not made at equivalent stress levels, as, for example, effective stress. In contrast, Thomsen and co-workers [12] again found excellent agreement between metal-cutting data and static-property test data of the workpiece when the effective stress was compared at the same value of effective strain. In the latter tests, it was shown that, with work materials of varying sulfur content up to 0.37 per cent, sulfur apparently does not affect the plastic-flow properties of the workpiece. The tests also showed that sulfur content above about 0.2 per cent can be as effective in reducing tool forces as can a reduced tool-chip contact surface at its optimum value. Shaw and co-workers [13] tested the identical sulfur steels and found that sulfur is only effective at low speeds and apparently shows little advantage over nonsulfurized steels at speeds of about 400 to 500 fpm and feeds up to 0.012 ipr. A variety of materials were tested by Kobayashi, et al. [14] (already reported in the 1959 review, Ref. [15]) and show that the correlation of metal-cutting stresses with those of the work material is satisfactorily done by the use of an effective stress. They also show that the shearing stress on the shear plane remains constant over a wide range of cutting conditions. Klushin [16] discusses the contact zone between tool and chip on the face of the tool. He presents formulas for calculating this length, as well as the peak and average normal stresses in steels. He shows that, for an undeformed chip thickness of 0.006 ipr or less, the normal stress distribution is triangular, with the maximum pressure at the cutting edge. For larger thicknesses, the pressure is uniformly distributed. The author gives comparisons of experimental results with theory, but does not derive the equations nor discuss the experimental technique used. Usui and Takeyama [17] apparently confirm Klushin's tests in that they found that the maximum tool pressure was at the edge of the tool when machining lead with a plastic tool. The authors used the photoelastic method for the determination of stress distribution on the face of the tool. Kececioglu [18] discusses the shear zone size in cutting SAE 1015 steel under a variety of cutting conditions and comes to the conclusion that the only size effect in metal cutting is the shear-zone size effect. Albrecht [19, 20] discusses ploughing of the cutting edge and a modified theory of chip formation. He assumes, in addition to shearing, that bending must take place on the shear plane, because the force is not uniformly distributed along the tool face.

Wear, Friction, and Temperature

Golden and Rowe [21] with a modified Bowden-Leben apparatus used radioactive copper and Duralumin to study qualitatively pickup on carbide sliders for various surface conditions. The investigators found that there appears to be a close relationship between the transfer of metal to and from the carbide and its wear. Goddard, et al. [22] from studies with emery paper rubbing on various metals were able to explain the abrasion process and gave a wear-rate equation. Ham and Stanislao [23] measured flank wear without removing the tool with a modified Brinell microscope. Engstrand [24] measured tool wear by means of a tungsten isotope and a scintillation detector and believes this method is best for wear studies of turning tools. Gibson [25] demonstrates experimentally that true wear at the flank of a tool cannot be obtained unless a thin layer of oxide, which forms on the tool, has first been etched off. Paliobagis and Krabacher [26] discuss the several conventional methods for measuring wear and report on special studies with radioactive tools. Kobayashi and Thomsen [27] report on friction with controlled flank and tool-chip contact areas. They found that friction on the controlled tool face approximately followed the von Mises plastic flow rule and that sublayer motion apparently was in progress. Chao, et al. [28] performed a unique experiment for measuring the flank temperature distribution of a tool during cutting. This was done by having a lead-sulfide cell as an infrared detector sensing the local flank temperature through a hole in the wall of the tubular workpiece. They then proceeded to calculate the tool-chip contact temperature from the data and found that the temperature is highest at a point on the face of the tool approximately at 0.6 of the tool-chip contact length. Hollander [29] determines isotherms by means of a radiation pyrometer focused on a small spot of the workpiece below the finished surface. It is claimed that the instrument sees a spot only 0.0016 in. sq. The result indicates that the temperature gradients in the workpiece near the surface are quite steep.

Vibration

El'Yasberg [30] presents a theory on self-generated vibrations in metal cutting, showing calculations and agreement of theory with experiment. Poduraev and Zakharov [31] give a theoretical and experimental study of chip breaking by means of induced vibrations. The vibrations, parallel to the feed direction, were induced in the tool by a hydraulic oscillator mounted on the saddle of a lathe. It appears that this type of induced vibrations has advantages, although under some conditions the tool life was lowered. Berthold [32] performed cutting-force studies and found that the forces vary with natural frequency. The author concludes that chatter is primarily due to frictional drag.

Nonconventional Machining Methods

A report on hot machining appeared in the magazine *Steel* [33]. It is claimed that the tests at North American Aviation yielded results which indicated that the removal rate of some high heat-resistant steels may be eight times that of conventional cutting. Pentland,

et al. [34, 35] also report on hot machining in turning and milling. They show increases in removal rate up to 100 times that of conventional cutting for Thermold J (390 Bhn) at 1000 F. Monahan, et al. [36] report on subzero machining and indicate that low-temperature cutting is beneficial in extending tool life up to 300 per cent for some conditions of machining five superalloys. Vaughn and Krueck [37] report on ultrahigh-speed machining by using, as the workpiece, a projectile fired from a 20-mm gun. The results indicate feasibility; speeds at 12,000 fpm were found to be best. Another report of the same project was also given by DeGroat and Ashburn [38]. Bredendick [39] analyzes the dynamic forces and comes to the conclusion that only at ultrahigh speeds do they become important and that they are of the order of 0.01 to 1 per cent of the static forces at conventional speeds.

Machinability and Tool Life

Lamb [40] reports on machining studies of nodular cast iron and steels and found that the machinability of cast iron was superior. Schmidt, et al. [41, 42] report that crater wear is not observed in ceramic-tool cutting tests and that these tools show improvement in performance over carbide tools at the higher speeds. Remmerswaal [43], with tests on pearlitic cast iron, also shows that better performance is obtained with ceramic tools than with carbide tools at the higher speeds. Jones [44] makes an analysis of the influence of the cutting temperature on tool life and demonstrates why feed has a smaller effect on tool life than cutting speed. Takeyama [45] describes a process of getting the cutting conditions for optimum tool life when turning stainless steel 18-8. Bodart and Andri [46] made tool-life studies of the effect of variation of clearance angle and rake angle using an 18-4-1 tool and a 0.55 per cent C steel workpiece. The results showed that V_{60} decreased linearly with increasing clearance angle, while for increasing wedge angle V_{60} increased. Engstrand [47] studied tool wear using a compensating circuit and concluded that it was of no consequence at this time in reducing tool wear. Bendixen [48] and Tschirf and Eder [49] present equations for tool life and machinability.

Tool Dynamometers

Several dynamometers are mentioned in the literature which may be of interest. Berthold [50] describes a lathe dynamometer which is used for dynamic measurements. Mukhin [51] describes a novel three-component dynamometer which has very low cross-coupling effect. Variation of point of application of load does not produce essential changes in sensitivity. The instrument consists of a cube which has three mutually perpendicular columns at each corner, that is, 24 columns, each provided with resistance strain gages. Voronin [52] describes a so-called "fast" three-component dynamometer which is rigid and capable of recording accurately rapid changes of load in the range from 20 to 600 kg at any cutting speed. It is insensitive to vibrations and has a natural frequency of not less than 2300 cps. Roubik [53] gives milling forces measured with a planetary-gear torquemeter. The author obtained tangential force measurements over a wide range of cutting conditions and verified the high efficiency of the device. Oscillations superposed on the basic force pulse were believed to be due to both the deflection in the gearing and the mechanism of chip formation.

Electro and Ultrasonic Machining

Trzeciak and Boulger [54] review the development of spark-discharge and electrolytic machining. They also discuss the probable mechanism of the processes and current practice. Holm [55] discusses the principles of operation of spark machining and points out that the tool force is essentially zero during machining. Comstock and Williams [56] give a mathematical analysis of a cylindrical current column of uniform current density. The solution should be of direct value in studying electrode phenomena in spark machining. Opitz [57, 58] discusses the variables in spark-erosion machining processes and the metallurgical aspects and surface characteristics. He gives experimental results of machining steel and hard metals and discusses the temperature-affected layer of a spark-machined surface. The author also shows hardness-depth curves for a spark-eroded test piece and recognizes and describes four zones adjacent to the surface. Williams [59] outlines the basic principle of electrolytic machining and its relationship to Faraday's law. The author states that the current efficiency may be of the order of 75 to 90 per cent depending upon the material, electrolyte, and work configuration. Backer and Dahlin [60] in tests with plunge-surface grinding with simultaneous electrolytic deplating found that the current efficiency was of the order of only 50 per cent. The authors found a relationship between the chip geometry and the current. Cole [61] also investigated electrolytic grinding but found that the Faraday current efficiency was near 100 per cent at current densities of 700 amp per sq in. The author concludes that the scrubbing action of the grinding wheel prevents the passivation of the work anode. The high current efficiency obtained by the author apparently was due to the fact that the plunge-grinding process consisted of grinding the end of a small narrow bar and hence the gap between wheel and work was essentially constant. *Aircraft Production* [62] describes the Zeiss electron-beam machining unit. It is claimed that slots and small holes of the order of 0.001 in. can be machined. The beam is highly concentrated and very little heat enters the bulk of the material. The welding of light sections can also be advantageously accomplished with this device. Gage [63] describes and analyzes the plasma-jet machining process. He discusses also the principles involved and the operational variables. Markov [64] discusses two ultrasonic machining processes, that is: (*a*) Machining at high frequencies (430 kc per sec) and small amplitude for finishing and deburring, and (*b*) at lower frequencies (16 to 30 kc per sec) at amplitudes of 0.0004 to 0.002 in. for more rapid stock removal. The author believes that spark-erosion machining followed by ultrasonic finishing may be an economical combination of processes.

Residual Stresses, Forces of Worn Tool, etc.

Lihl and Lawatsch [65] determined the depth of surface affected by shaping a low carbon steel (C = 0.15 per cent) in the normalized condition. They showed that for their tests the depth of the deformed layer was a function of volume rate of stock removal. Halverstadt [66] discusses residual stresses due to various machining processes and their effects on the performance of machined parts. He gives also approximate depths of affected surface metal during various machining processes. McAdams and Rosenthal [67] analyze the forces due to flank wear of cutting tools. They assume a

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linear increase in forces due to flank rubbing with increasing wear land. They set up analytical expressions for the tool force in the feed direction for several conditions of cutting. Mueller [68] presents experiments with a turning tool having a primary and secondary rake angle of −10 and +10 deg, respectively. Results show that crater length is minimum up to 16 minutes of cutting, when the primary tool-surface land length is approximately twice the thickness of the undeformed chip thickness.

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METAL CUTTING PRACTICES

By J. R. Roubik,[7] A. L. Pickrell,[8] K. H. Moltrecht,[9] R. L. Vaughn,[10] J. A. Sweeney,[11] and E. J. Weller[12]

A magnetic-tape modulator head described by Anderson [1] is an important advance in instrumentation and appears to be first in its field. The device has potential widespread application in addition to usage in machine control. Rather than rate-of-change of flux, the head senses flux from a magnetic tape. Since voltage is independent of tape speed, applications include data reduction through reduced-speed playback for transient analysis and frequency-bandwidth reduction permitting transmission of data over ordinary telephone lines.

A very complete and informative article on numerical control by Stocker [2] not only explains the fundamental concept, distinguishes between simple counting, point-to-point, and continuous-contouring systems, but contains an evaluation, describes the advantages, and includes a glossary and partial bibliography.

To suitably employ numerically controlled machine-tool systems, particularly contouring systems, the surface to be machined must be mathematically defined taking into consideration the constraints on the motion of the cutter relative to the workpiece. DeBiase [3] gives the general procedure for defining a turbine-bucket surface in terms of unequally spaced cross sections along the length of the blade and an interpolating procedure for the entire surface with properly faired transitions between the specified cross sections.

A series of 12 papers (in German) [4] describes the design, construction, operation, and various applications of the Simatic (Siemens) control system utilizing static switching (transistors) rather than dynamic (mechanical) in logic circuitry. The system resembles several made in the United States. Such systems are intended for use where a very large number of switching cycles are required, where the switching is very complex, where the speed or time of response of switching must be minimized, and where the system reliability must be very great.

A mathematical determination and a graphical solution of the minimum-cost machining conditions for an optimum number of machines were made by Mannell [5].

Very accurate aluminum electronic computer memory drums are being produced by Librascope with machining tolerances held to 0.000050 in. on a specially built machine called Van's Drum Machine [6]. Specially ground diamond tools, coupled with a precise pneumatic-hydraulic tool feed, allow finishes of 8 microin. to be obtained in the as-cut condition. Air conditioning in the shop allows a fixed machine-tool and part temperature.

The drum machine is mounted on a 24 × 36-in. delta drill-press table which was scraped and hand-lapped before assembly and is fastened to Meehanite anchors sunk in a 1-ton block of cement. Tool-feed speeds vary from $1/4$ to 5 ipm. A 1-hp 220-volt enclosed motor provides a speed range of 600 to 5850 rpm to thin belts which rotate the drums. A pneumatic cylinder drives the toolholder. Control of the oil flow from a hydrocheck cylinder, against which the pneumatic cylinder works, regulates the speed of the toolholder.

Gun drilling was used to bore a 35-in. billet of beryllium copper at Douglas, El Segundo, because of its ability to provide a very straight hole, which in turn facilitated subsequent boring [7]. The part was turned

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with the drill stationary on a Monarch lathe at 400–450 rpm. Coolant was supplied at 100–125 psi. To provide maximum rigidity for the subsequent boring operation, the boring bar was traced to the same contour as the hole. The same template was used for boring.

The increasing use of beryllium and other toxic materials in industry has created a definite health hazard [8]. Special filtration and collection equipment has been developed to intercept very small particles, fumes, dust vapors, chips, and powders produced by machining and other fabrication processes before they can enter the breathing space of any employee.

A circular saw, described by Kurchenko [9], for cut-off duty uses electrolytic action in the lower feed ranges and, from the description, electric arcing in the higher. By use of ceramic guides to prevent waving and jamming of the wheel and rotating the workpiece, which reduces the arc of contact, considerably higher metal-removal rates are claimed. Silicates or water-glass are used for an electrolyte and coolant as feed conditions require.

The machining of Zircaloy-2, graphite, aluminum X-8001, Mallory 1000, uranium, and concrete is covered in a well-illustrated article [10].

The workpiece must be flooded in machining Zircaloy-2, since it is pyrophoric. Tools must be kept sharp, fine chips avoided, and adequate feed per tooth or revolution provided. Carbides provide good enough surfaces to permit surface bonding without added operations.

The obstacles already encountered in metal removal for aircraft and missile manufacturing and some which will be met are described in a paper by Field [11]. The greatest obstacle is the approximately 100 times reduction in metal-removal rates encountered when changing from aluminum to superalloys.

The drastic change in tool life when milling the superalloys (U-500, VascoJet 1000, and so forth) is shown.

The nonmachining methods of material removal such as chemical milling, electrical discharge, electrolytic, and ultrasonic processes are covered.

The health-precautions costs for the new facility at Armstrong-Whitworth Aircraft for handling and machining of beryllium were approximately three times the production-equipment costs [12].

Protective clothing is used as well as rigid measures to prevent spillage of the toxic dust. Glove ports, vacuum exhaust systems, cyclone separators, and fire precautions are other safety measures.

Machining of the high-nickel Nimonic series of work-hardening alloy is very difficult and is described in *Aircraft Production* [13].

For grinding, the recommendations are different from some of those in this country in that conventional wheel peripheral speeds (5000 to 6000-fpm) are recommended. Many manufacturers here use lower (2000 to 4000-fpm) speeds. Use of soluble oils promotes wheel cleanliness and grit breakdown by reducing loading of the wheel face.

For honing, speeds are conventional. Reaming and drilling follow accepted practices. In milling generous positive rakes, high clearance angles and climb, slab-milling is preferred.

The methods of spar milling, trimming, forming, and welding, used by Vickers-Armstrong, Ltd., in the machining of magnesium fuel-channel sleeves for the Berkeley Atomic-Power Station Reactors [14], were common ones for fabricators familiar with magnesium. However, the special cleaning procedures used and the design and application of the straightening tools were new.

No automatically noncompatible material such as boron, lead, zinc, or bronze could be allowed to come into contact with the sleeves during machining.

Special clothing and a partitioned and cleaned area were used for processing with final packaging in a "dust-free" room. An unusual split-form steel die, at 350 C, was used for straightening the sleeves.

Three different types of chemical-milling operations are explained by Kincaid and Zants [15]: The chemical scalloping and grooving of an aluminum wing beam; the chemical milling of adhesive bonding tools to accommodate different part thicknesses; and chemical cleaning of aluminum castings whose internal stainless-steel fuel lines were partially obstructed with spattered aluminum. The masking procedures used to clean aluminum castings are considered unique.

Experience with molybdenum fabricating techniques at five shops was reported as follows [16]: "Experimental Machining at Custom Tool and Manufacturing Co., Minneapolis," by R. Williams, pp. 121–123; "Where to Start Grinding Molybdenum," by J. A. Mueller, p. 124; "Chemical Milling Works Molybdenum," by J. E. Wilson, p. 125; "Why Molybdenum Is Tough Metal to Machine," by H. J. Siekmann, pp. 126–127; "Electric Discharge Deep-Trepans Molybdenum," pp. 127–128.

Molybdenum can be machined on standard equipment using conventional techniques without difficulty [16]. However, to obtain reasonable tool life, the material must be cut under specific conditions of tool material, tool geometry, speeds, feeds, and coolant.

The most informative section of this five-part report was the one titled, "Why Moly Is a Tough Metal to Machine." Here the mechanics of abrasive action are discussed and effects of cutting speed and side rake on tool performance are shown.

The need for quick-change cutter adapters in this age of transfer and high-production numerical-control machines is emphasized by Conn [17]. Cutter changing costs are usually many times the perishable tool costs and production is paced by the time spent in cutter changing.

An effective method is presented for obtaining precision running tools that use a bolt-on precision adapter and preset precision cutter. Basic limitations are the cost of adapters and rigidity.

Very useful production information on milling high-strength alloys is given by Zlatin and Krueck [18], including the development of preliminary cost estimates.

Milling characteristics and recommended cutting conditions are provided for several metals, representative of five groups: medium carbon alloy steel, austenitic stainless steel, martensitic stainless steel, high-temperature nickel, and cobalt-base alloys.

Amstead [19] has presented very effectively the theoretical conditions (confirmed by test) for bar-stock

whip in high-speed turning of stock as in a screw machine. A formula determines whether the speed to be used will produce stock whip. Bars have a fundamental critical deflection speed and successive critical speeds called harmonics. Operation between these speeds was quite routine, and critical speeds would not produce severe bar deflection if the bar is rapidly accelerated through the speed. The critical speed can be changed significantly by imposing a small amount of tension on the bar.

The Battelle report [20] is probably the most complete presentation on the turning of high-strength steels available in industry today. It not only provides recommended starting points for turning, but also includes recommendations for handling the various options such as the use of carbide, ceramic, or high-speed steel cutters.

The Appendix includes heat-treat procedures that support high production and minimize part distortion, a new and up-to-date carbide-tool application chart, and a list of the commercial brands of ceramic tools.

Recommended conditions are given for machining AISI 4340 (52-R_c), Vasco Jet 1000 (52-R_c), AM 350 (solution treated and aged), and A-286 (solution treated and aged) in a useful report [21] on turning, milling, drilling, and tapping of ultrastrength alloys which will eliminate expensive trial-and-error tests.

An optical technique for aligning long-bed lathes, including cross slides and turrets [22], yields results which depend upon the individual machines. A typical result had a total cumulative error of the ways within 0.0025 in. (vertical and horizontal planes) in 55 ft.

Although entitled "An Introduction to Interferometry," O'Donnell's work [23] is of sufficient scope and depth to suggest possible new approaches to measurement and inspection techniques where high accuracy of measurement and/or extremely small dimensional tolerances are required.

In addition to the general aspects of geometrical and physical optics, six specific types of interferometers are explained and discussed.

Possible light sources for use with interferometers and the accuracies of measurement which are obtainable are also dealt with.

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PLASTIC WORKING

By Francis W. Boulger[13]

Forging

Most of the significant advances in metalworking processes have resulted from engineering developments in equipment. There are some encouraging signs, however, that metallurgists are contributing to progress by improving materials intended for specific processes.

Brown [1] describes the fabricating troubles attributable to shortcomings in forging-quality steels. The article describes various difficulties in forging, extrusion, pressing, and cold-extrusion operations. Yukawa [2] concluded that the strength and fracture characteristics of large alloy-steel forgings are modified by the presence of nonmetallic inclusions.

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Rolls and Preece [3] established that the effects of nickel, tin, and copper as tramp elements in forging steels are influenced by other factors. Forging temperature and composition of the furnace atmosphere are particularly important. Higher forging temperatures and sulfur-free atmospheres are usually better. Copper contents over 0.2 per cent cause hot cracking because preferential oxidation causes copper to concentrate at grain boundaries and on the surface. Nickel increases the propensity for hot tearing of copper-bearing steels heated in neutral atmospheres containing sulfur dioxide. Tin in amounts up to 0.06 per cent had no effect on hot cracking.

Forging parts to precision tolerances is the elusive objective of much research and development. A survey-

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type article [27] describes the approaches to forging precision parts from titanium, beryllium, superalloys, and refractory metals. One useful expedient is to use hot dies. Gouwens [4] reports on promising work with cast nickel-base dies heated to 1600 F by resistance cartridges. Reasonably close tolerances were maintained in forging 4340 steel. The dies gave better spreading and permitted 80 per cent deeper flanges when operated at 1600 F than when warmed to 800 F.

Tomlinson and Stringer [5] tell how to predict elongation and spreading when forging billets with flat tools. Each stroke seems to contribute more to elongation when wide tools and heavy blows are used. Wistreich and Shutt [6] developed a theory on cogging of square sections to find the parameters needed to specify optimum working practices. The information should be useful in planning and improving automation in forging operations. The economic effects of changes in equipment and practices in English shops were discussed by Colcutt and associates [7].

Studies at BISRA during the past five years have led to control systems for forging simple shapes [8]. Production rates can be doubled by automatic control of presses and manipulators. More complicated shapes and self-programming techniques are being developed.

Rolling

As usual, knowledge of the rolling process was sought by experiments on both laboratory and full-scale equipment. Polakowski and Schmitt [9] compared the rolling, extrusion, and drawing process by cold-reducing bars. In their slow-speed experiments with a mineral-oil lubricant, friction coefficients ranged from 0.09 to 0.14. The data showed that the rolling process was most efficient but the lack of a good universal theory prevented a complete analysis of the results. As the draft increased, unit rolling pressures decreased for steel but remained constant for aluminum and copper. The authors attributed this behavior to variations in the original elastic limits and the strain-hardening rates of the materials. Okamoto's [10] measurements of specific pressures developed in hot-rolling sheet agreed satisfactorily with those predicted by Orawan and Sims.

Wallquist [11] expanded his studies on flats to cover the hot-rolling of diamond, square, and oval sections. The investigation covered the effects of size, shape, and temperature on rolling pressures, energy consumption, spread, and slip. Shape has a more marked effect on the total roll pressure than on energy consumption. The experiments appear comprehensive enough to permit others to make useful predictions on performance characteristics from their data on flat-rolled stock.

Round billets for seamless tubes are usually pierced in a two-roll, cross-rolling mill. Teterin [12] and coworkers found that billets can be pierced with less axial slip and less power in a mill with three driven rolls. Observations on the small experimental mill indicated that the three-roll technique developed higher piercing pressures but minimized the likelihood of axial ruptures and other internal defects. Granovskii [13] and associates extended the studies to the process of elongating pierced rounds. They reported that the three-roll mill gave poorer control of wall thickness in pierced rounds than the conventional two-roll mill. By using a mandrel with a cylindrical portion behind the point, however, piercing the elongating operations could be combined in one process. With this technique, about 90 per cent of the tubes had wall thicknesses within one tenth of the nominal value. The combined piercing-elongating process was judged suitable for producing thick-wall tubes in one pass.

Sheet Forming

Since die wear and burring are common problems in stamping blanks from sheets of high-silicon electrical steel, the report by Griffiths [14] on a test method for establishing punchability ratings should be of widespread interest. It evaluates information on the effects of die, press, sheet, and lubricant characteristics on punching operations. Many metalworkers believe that thickness influences the ductility of sheet materials. An analysis of information on this subject by Rudnick and Carlson [15] shows, however, that the effect should be attributed to cross-sectional area. For specimens long enough to avoid end effects, proportional increases in width or in thickness are equivalent in raising the total elongation of tensile specimens.

Extensive work, by a British group, established that the performance of sheet materials in the Swift cup-drawing test correlates with results in commercial deep-drawing operations. That is, the test indicates the limiting depths of draw and the propensity for splitting. The latest investigation [16] was concerned with a more subtle attribute, the ability of a sheet to assume the desired shape in pressing or stretching operations. Pearce [16] reports that the expected effect of aging on the performance of rimmed steel could be detected when a hemispherical rather than the usual flat-headed punch was used in the Swift test. The round-head punch produces more stretching and less drawing. It gives ratings for various materials correlating closely with Olsen values. Both of these test methods indicate aging is undesirable when wrinkle-free parts must be made by pressing. On the other hand, deeper cups can be drawn from aged than from unaged rimmed steel when a flat-headed punch is used.

After reviewing available information on high-energy forming methods, Wood [17] concluded that high-mass, low-velocity processes are most suitable for forming flanged stiffeners, and high-velocity methods are best suited to expanding tubes and sizing parts to close tolerances.

Extrusion

Aluminum-alloy screwstock is ordinarily produced by cold-drawing hot-rolled bars. A new cold-extrusion process for producing such products was described by Church [18]. The billets are cast semicontinuously in metal molds, homogenized, scalped, and lubricated. The billets are then extruded at 150 F in an extrusion press operating at a ram speed of 200 ipm. Extrusion ratios ranging from 8 to 1 to 35 to 1 are used to produce rounds, or shapes, from $^3/_8$ to $2^1/_2$ in. in diam. Flexibility and low capital costs allow the new process to compete with the conventional methods.

Bedeschi and Bracale [19] found that wrapping alu-

minum-alloy billets with pure aluminum foil offers advantages. Maximum extrusion pressures dropped one-fourth and formation of a rough, recrystallized surface layer on the bar product was avoided.

Pugh [20] pointed out that the hydrostatic stresses characteristic of extrusion processes enhance the ductility of brittle metals. Transmission of the extrusion force through a pressurized fluid would be expected to give even better results. He demonstrated this effect by experiments on bismuth. Morgan [21] presented a good description of cold-extrusion processes for steel. The comments on costs, tool design, operating stresses, and working temperatures are of particular interest.

An article by Butler [22] on conformation of deformed workpieces to the shape of the tools is of interest for several processes including extrusion. A thin, semi-continuous film of lubricant between the tool and the work prevents scoring and galling. If the lubricant is trapped, the metal is deformed largely by fluid pressure. This affects the surface conformation and produces a matte surface on the part.

The production of semifinished steel products by hot extrusion, a process which lags in this country, was the subject of several unusually good articles. Haffner and Sejournet [23] covered recent progress and trends in new equipment and plant layout. The information on billet lubrication and economics of the process is very useful. Cox and associates [24] discussed requirements for raw materials, billet heating, and die production based on five years' experience in extruding hot steel. They provided considerable information on dimensional tolerances, some for complex shapes, which can be maintained in production.

Sukolski and Hoyle [25] demonstrated that high-speed steels can be extruded satisfactorily at temperatures higher than those ordinarily used for forging and rolling. Working at higher temperatures breaks up eutectic structures and results in fewer carbide stringers. If oxidation was prevented, unsound ingots produced good extrusions. Naden [26] points out that die costs can be lowered by using die inserts and repair welding. Although wall eccentricity is a problem in tubes, extrusion permits production of thinner walls than other hot processes.

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CUTTING FLUIDS

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Cooling

Basic investigation of the cooling characteristics of cutting fluids covered many avenues of approach in addition to the two reasons for which cutting fluids are generally used: (*a*) Improvements of surface finish when machining at relatively low speeds, and (*b*) improvement of tool life when machining at relatively high speeds. Shaw, Cook, and Smith [1] in pursuing this work attempted, sometimes unsuccessfully, to measure temperatures during cutting in order to determine cooling characteristics. This work reaffirmed the important finding that a fluid can be too good a coolant and give tool life shorter than obtained without a fluid.

Similar results were confirmed by Hall [2], when the possible adverse effects of effective coolants are presented. These data show, *based on tool life*, that cutting

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oils are better than dry, while emulsions are worse than dry. *Based on workpiece finish*, oils help produce a better finish than dry, while emulsions produced variable results (some finishes were better than dry, some worse).

Fluid Spoilage

Spoilage of water-soluble cutting fluids as investigated by Flemming and Baker [3] was found to be predominately a bacterial action especially when foul odors are present where the release of molecular hydrogen is from an electrochemical action between the sulfur content of the iron fines in the system and the emulsion. With little or no sulfur in the fines, less than 0.01 per cent, no spoilage occurred. With fines containing 0.1 per cent sulfur the emulsion lasted only 5 days. This electrochemical action usually precedes bacterial growth and can greatly accelerate it.

A few ground rules may be stated to describe methods of preventing spoilage: (*a*) Maintain the emulsion pH above 9.6; (*b*) isolate fines from the system.

The rate of spoilage may be reduced through cleanliness, use of effective bactericide, maintaining high pH, (9.0 to 9.5), and use of low-sulfur bearing metals.

Performance

Evaluation of cutting-fluid performance by Feng, Gujral, and Shaw [4] centered around the crater that develops on the tool face. They report that the rate of crater development, or tool wear, is influenced by its shape which in turn is altered by a cutting fluid in such a way that tool life may be increased or decreased. The cutting fluid tends to control the size and stability of the built-up edge at low cutting speeds. Three screening tests were found to be of value; they are: the four-ball test, a tapping test, and a low-speed orthogonal-cutting test. Cutting-fluid additives were screened by the four-ball test. Finish and force characteristics were screened with the tapping tests and orthogonal cutting.

The data indicated that the crater produced with water as a cutting fluid formed more rapidly than when cutting dry and was closer to the tool flank.

Arundel and Kitchingham's [5] investigation of the machining of high-tensile steel using carbon dioxide as a coolant aimed at finding suitable cutter material, cutter geometry, and speeds and feeds to produce effective machining on steels of various tensile strengths on routing machines and high-speed and conventional milling machines. The economic impracticality was established of machining ultrahigh-tensile steels by routing or high-speed milling, except in certain restricted circumstances and then only with the use of CO_2 as coolant. The use of CO_2 shows a marked advantage in speed, tool life, and metal removal in all cases.

Several hundred nitroparaffin derivatives were studied [6] for their antimicrobial activity in metal-cutting fluids. Sixteen compounds were found to be inhibitory for bacteria. Study of these inhibitors in six different products against pseudomonads and sulfate-reducing bacteria showed that tris (hydromethyl) nitromethane exhibited superior activity against both aerobic and anaerobic bacteria.

A cutting-fluid-evaluation program [7] included preliminary screening tests and machinability tests. Screening tests insured that only products possessing superior physical properties were considered. A full-scale lathe-turning test compared cutting-fluid performance.

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GRINDING

By E. J. Krabacher,[17] R. S. Hahn,[18] and J. L. Wennberg[19]

One is shocked to find that only three of the 25 papers on grinding reviewed for 1960 are American, and of these only one is a research paper. Certainly something should be done to stimulate research in the grinding field. Although more work was probably done than appeared in the literature, and some papers may have been missed, the weight of evidence is clear.

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[19] Senior Research Engineer, The Cincinnati Milling Machine Company, Cincinnati, Ohio. Assoc. Mem. ASME.

Grinding-Wheel Wear

The nature of grinding-wheel wear received considerable study. Bruchner [1], using a new method of measuring the grinding-wheel wear coefficient ϵ, which is the ratio of the actual contact area of the wheel to the apparent surface area, found that it starts at about 3 to 5 per cent for freshly dressed wheels, rapidly increases at first as the wheel is used, and finally increases linearly reaching a value of the order of 12 to 14 per cent for a worn, dull wheel. Under some conditions the wear coefficient fluctuated, corresponding to periods of self sharpening.

The wear process is described as consisting of a grain breakout, occurring in freshly dressed wheels, followed by microscopic splintering of grains and by grain wear through pressure softening and temperature.

Wheel wear passes through definite phases, according to Koloc [2]. Initially, high nonlinear wear depends upon the dressing regime, while the second phase gives a constant volumetric wear rate. As wear progresses, wheels dull until a boundary is reached between dulling and self dressing.

"Studies in Grinding" [3] was a collection of papers on research conducted in the Machine Tool Laboratory of the Rheinisch-Westfalischen Technischen Hochschule, Aachen, Germany. Although these were originally published in 1958, they are reviewed here since they are of high quality and have not been covered by previous literature reviews.

Vibrations and Chatter in Grinding

Puzanov [4] studied the nature, magnitude, and minimization of vibration in plunge grinding. He measured vibrations at the end of the grinding spindle relative to the grinding head and defined the existence of four distinct types of vibrations in the cutting zone influenced by both external and self-induced vibrations.

In an analysis of a regenerative type of chatter in centerless grinding by Plainevaux [5], the grinding wheel is considered to be elastically restrained. Vibration transients are ground into the workpiece which appear as undulations and re-excite a vibration, one half a work revolution later, when they meet the regulating wheel. This process is described by a fourth-order difference differential equation with a retarded action in a displacement term. Stability criteria are given. The development of 3, 5, 7, . . . lobes are explained.

Kaliszer [6] considers wheel unbalance in external grinding machines, first, as a two-degree-of-freedom system composed of the wheelhead and the base, and then with the wheelhead considered as a two-degree-of-freedom system, the unbalanced spindle being one member and the housing the other member.

In experiments on two internal center-type machines vibration amplitudes were measured under various conditions for wheel unbalance, using a roller-bearing spindle and a plain-bearing spindle. The unbalance due to coolant absorption into the wheel was also measured.

Lur'e [7] gives a qualitative account of some studies of grinding-machine vibrations made at the Moscow Auto Institute. The increase in vibration amplitude with grinding time was studied under varying conditions of wheel speed, grit size, wheel hardness, and similar factors. A self-excited vibration develops as the wheel becomes dull. Increased grinding feeds cause a more rapid growth of the amplitude. Increased wheel speeds cause a slower rate of growth of vibration when grinding at a fixed feed. The amplitude for 80-grit wheels increased at a slower rate than for 60-grit wheels. The results of experiments are presented in graphs. No analytical work is included.

Properties of Grinding Wheels

Peklenik [8 and 9] describes a device for measuring the force necessary to break individual grains from a grinding wheel. A pointed tool is drawn across the wheel face and the momentary forces recorded and correlated with the type of tool-grain engagement, that is, direct breakage of a grit, or a sidewise impingement, or breakage of a group of grits.

Another device is described for measuring the local deformation of grits. Results are given in an accompanying paper [10].

The elastic deformation during grinding is referred to briefly. Experimentally measured bond-rupture forces were obtained and were plotted against the Norton hardness scale.

An additional paper on the subject [11] deals specifically with a technique for testing the toughness of abrasive particles.

An investigation dealing with abrasive grain toughness [12]—that is, the ability of abrasive grain to resist impact, pressure, shear, and wear—classified and described ten tests used in Germany, Austria, and the United States. Sensitivity of toughness values to grit size, shape, sieving method prior to test, and velocity of test are pointed out. Four selected tests were evaluated.

Wheel Truing

Investigating the influence of crystallographic orientation on the wear of truing diamonds with pyramidal diamond tools of both gemstone and industrial quality, Pahlitzsch [13] found that the octahedron face showed the greatest resistance to wear. The volume of diamond worn away was related to the volume of grinding wheel removed. The natural surface of a rough diamond was found to possess superior wear properties to that of a polished surface of the same crystallographic orientation. The effect of diamond-dressing techniques on surface finish in grinding, and a photographic set-up for observing behavior in the wheel structure were reported by Schwartz [3]. Frank [3] studied the profile dressing of grinding wheels with shaped diamonds.

Robison [14] used a rotary dressing tool to dress and maintain accurate wheel contour at full grinding-wheel speed. Complex wheel contours were maintained within 0.0005 in. and had long life, permitting more complex single grinding operations without infringing on productive time.

Pahlitzsch and Thoeing [15] found that, in the truing process in grinding, the so-called abrasive surface roughness of the wheel was affected by diamond geometry, infeed, and traverse rates across the wheel. This surface roughness of the wheel is related to finish obtained.

The Grinding Process

There are very few references in the 1960 literature in the area of grinding mechanics. Peklenik [3] contributed two—the first on the mechanism of grinding and the second on the determination of the chip thickness in grinding.

In dry grinding of steel using Al_2O_3-coated abrasives, Durvell and McDonald [16] found that the fresh metal surfaces created during grinding reacted rapidly enough with atmospheric oxygen to drastically decrease frictional forces in grinding. This was in keeping with findings of Shaw and others. Certain other group VIA and VIIA elemental gases were found to be more effective "gaseous lubricants" than oxygen.

In an investigation of work-surface temperatures in grinding, Redko [17] describes the nature of frictional heat, and derives the relationships for calculating surface temperatures through the summation of the individual heat impulses of the individual abrasive grains. The way in which heat is accumulated in the surface

Metal-Processing Literature

layer is also defined. Heat in the workpiece surface was determined indirectly by comparing the depth of the layer of martensitic-austenitic transformation in the machined surface by means of 50 taper sections.

Grinding Accuracy and Control

In a paper concerned with errors in plunge grinding Bramertz and Kohlhage [18] find that the grinding forces caues angular and lateral deflections which result in unwanted taper. Unequal cooling along the wheel-work contact causes a concave-form error. The influence of the rigidity of the grinding wheel and work on spark-out time is studied.

Peklenik [19] discusses various sources of error found in grinding machines and how they affect the size-holding ability. The wear of the dressing diamond, the elastic deformation of the grinding spindle or workpiece, as well as the thermal expansion of the workhead and diamond are considered.

Diamond Grinding

Man-made diamonds continue to receive attention. In an article in *Steel* [20], the General Electric Company reveals specific information concerning the manufacturing process.

Extensive tests were conducted in the Diamond Research Laboratory of Johannesburg, South Africa, to control all variables significantly affecting performance [21]. Man-made grits were found more friable and less blocky than natural grit, remaining in the wheel longer.

Storchak [22] reviewed Russian research and practice with organic-bonded natural diamond wheels.

General

A historical study of the grinding machine by Woodbury [23] covers grinding from the early mechanization to the modern production machines relating their influence to industrial production.

Yakimov and Kravchenko [24] measured grinding forces and the degree of work-hardening form-grinding operation on gas-turbine blades in an effort to optimize the process. Due to interrupted cutting, the impact forces were found to be 3 to 4 times greater than stabilized loading. Increased work-hardening accompanied impact loading. Flood cooling reduced impact loading by 25 to 30 per cent and stabilized loads by 50 to 65 per cent.

The grinding of high-strength steatitic ceramics was investigated by Ramanov and Grinchenko [25]. Various grinding wheels, grinding fluids, and grinding parameters were examined to determine optimums. Silicon-carbide wheels were recommended for roughing and semifinishing, while metal-bonded diamond wheels proved most economical for finish grinding.

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J. Peklenik, "Beitrag zur Bestimmung der Spandicke beim Schleifen" (Report on the Determination of the Chip Thickness in Grinding).

J. Peklenik, "Untersuchungen über das Verschleisskriterium beim Schleifen" (Investigation of Wear Criteria in Grinding).

K. E. Schwartz, "Zerspannungsvorgange und Schleifergebnis beim Abrichten von Schleifscheiben mits Diamanten" (The Cutting Process and the Grinding Results for Diamond Dressed Grinding Wheels).

H. Frank, "Untersuchungen über das Profilabrichten von Schleifscheiben mit Form diamanten" (Studies on the profile-dressing of grinding wheels with shaped diamonds).

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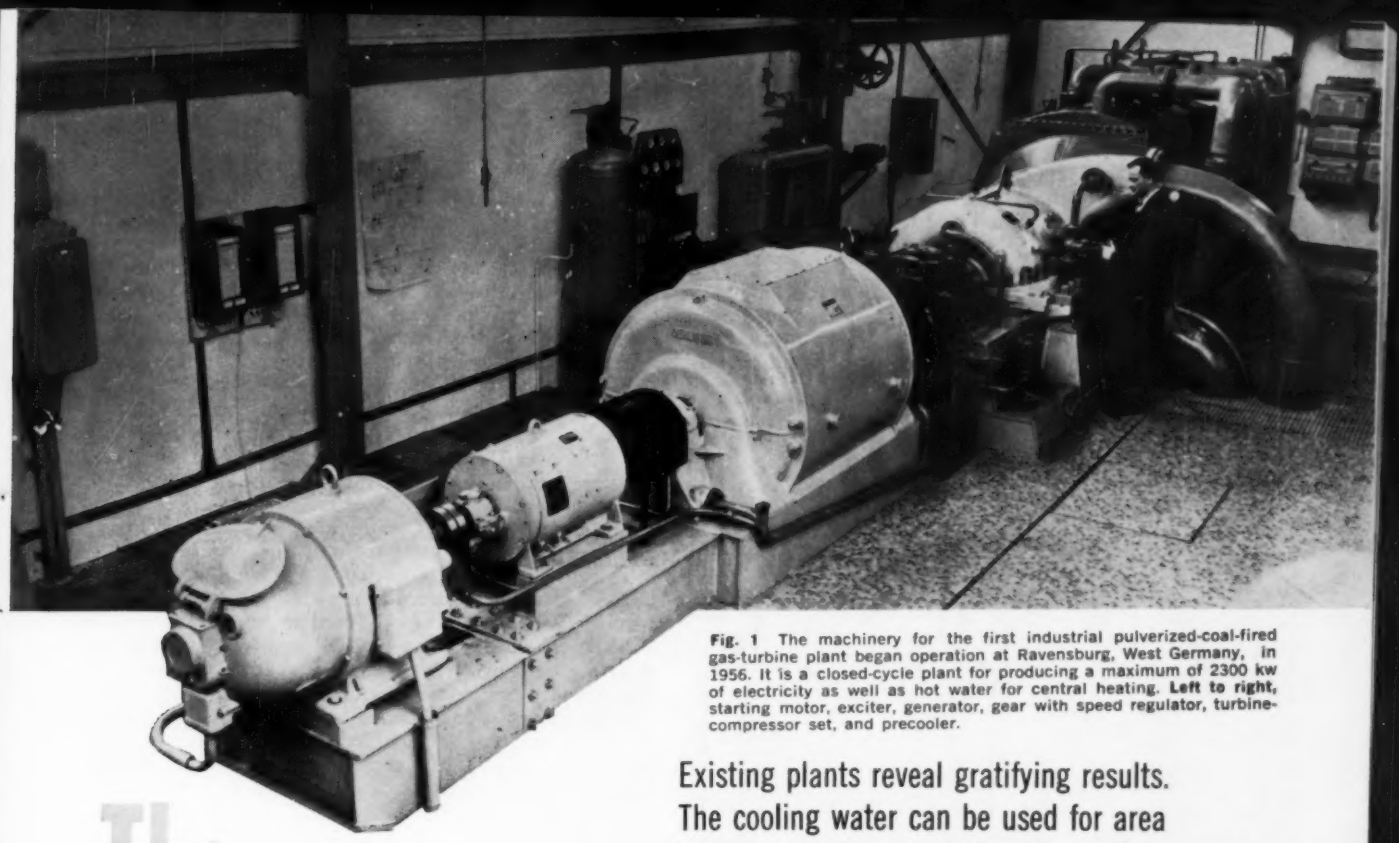

Fig. 1 The machinery for the first industrial pulverized-coal-fired gas-turbine plant began operation at Ravensburg, West Germany, in 1956. It is a closed-cycle plant for producing a maximum of 2300 kw of electricity as well as hot water for central heating. **Left to right,** starting motor, exciter, generator, gear with speed regulator, turbine-compressor set, and precooler.

The COAL-BURNING Closed-Cycle Gas Turbine

Existing plants reveal gratifying results. The cooling water can be used for area heating, and the simplicity of operation promises successful use in isolated, self-controlled plants.

By C. Keller,[1] Mem. ASME, **and W. Gaehler**[2]

Escher Wyss Ltd., Zurich, Switzerland

SINCE 1956, when the last report on closed-cycle gas-turbine development was presented in the U. S.,[3] six solid-fuel-fired plants, rated from 2 to 13.5-mw, have come into operation. Additional oil and gas-fired installations, both for stationary power plants and ship propulsion, have been built and operated or will soon start operation. Unfortunately, none of these are in the U. S.

[1] Director of Research and Development.

[2] Chief Engineer, Gas Turbine Division.

[3] Curt Keller, "Operating Experience and Design Features of Closed-Cycle Gas-Turbine Power Plants," *Trans. ASME*, vol. 79, 1957, pp. 627–643.

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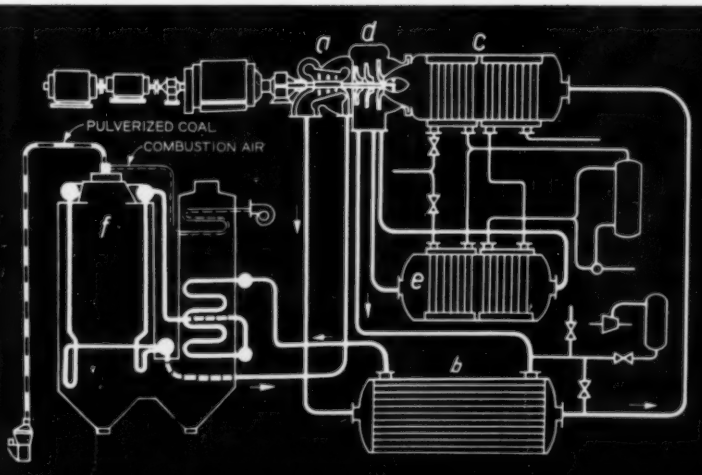


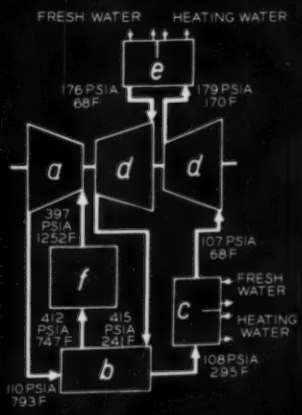


Fig. 2 Schematic of the Ravensburg plant.
a = turbine
b = recuperator
c = precooler
d = compressor
e = intercooler
f = air heater

A summarizing report will be given on these installations, particularly the coal-fired sets. A status list as of the end of 1960 is given in Table 1.

The Ravensburg Installation

The first industrial pulverized coal-fired plant at Ravensburg, West Germany, started operation at the beginning of 1956, Fig. 1. It is a combined installation for power production (2300 kw max) and central heating (10,000,000 Btu per hr max) in the form of 170/110-F hot water. Since 1957, it has operated practically without trouble. The availability of this pioneer plant in the different years is shown in Table 2. The time for normal revisions and checks can be determined by the operator and is no longer dictated by difficulties with the plant.

The plant produces all of the power for an 1800-employee machinery works and the waste heat (hot water for room heating) is sufficient to heat the entire establishment, including office buildings, when ambient temperatures are as low as 0 F. By the end of 1960, the plant had achieved 24,650 hr of industrial service and produced over 31.6 million kwhr. Over 123 billion Btu of waste heat had been used for room heating and hot-water production.

The first pioneering small-scale tests with coal and peat-fired air heaters were made in 1950 and 1951 at the John Brown works at Clydebank, Scotland, a licensee of Escher Wyss. In December, 1951, the first test gas turbine (500 kw) with a peat-fired air heater was started at these works. The pulverized peat with an original moisture content of 50 per cent was dried to about 25 per cent moisture content by the flue gases, which had a temperature of about 660 F.

At the burner, the moisture content of the peat was reduced to about 5 to 6 per cent by the preheated combustion air. The test turbine ran some hundred hours,

The COAL-BURNING Closed-Cycle Gas Turbine

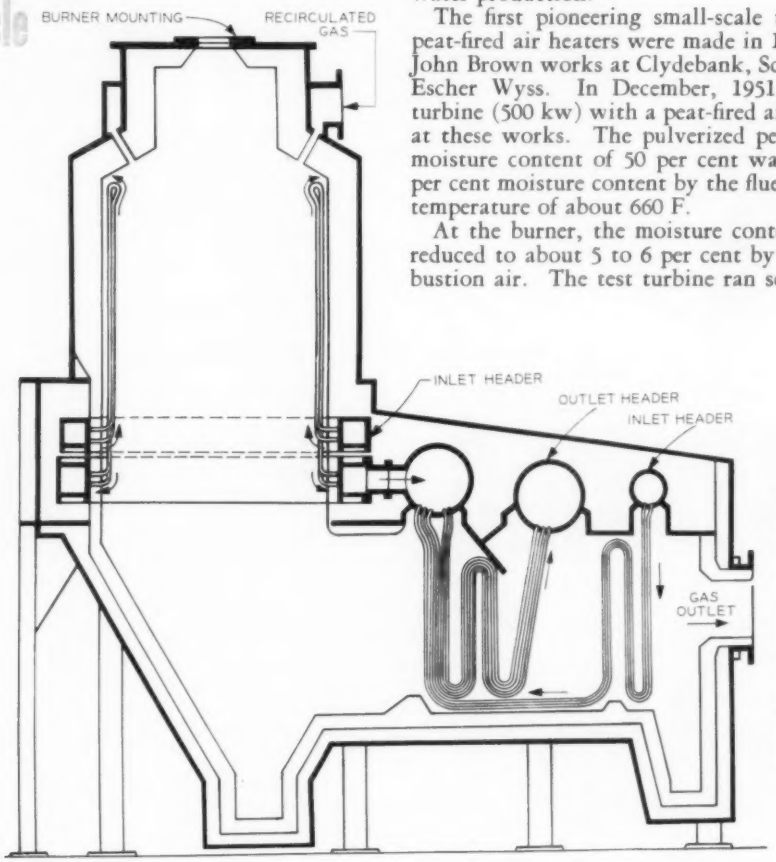


Fig. 3 A section of the small-scale peat-fired air heater used in tests made in 1950 and 1951 at the John Brown works in Clydebank, Scotland. Pulverized peat with an original moisture content of 50 per cent was dried to about 25 per cent moisture content by the 660-F flue gases. At the burner, the moisture content was further reduced to about 5 to 6 per cent by the preheated combustion air.

Table 1 Main Data on Industrial Solid-Fuel-Fired Closed-Cycle Gas-Turbine Plants

	Ravensburg, W. Germany	Coburg, W. Germany	Oberhausen, W. Germany	Moscow, Russia	Altnabreac, Scotland	Rothes, Scotland
Built by	Escher Wyss/GHH	GHH	GHH/Escher Wyss	Escher Wyss	John Brown	John Brown
Purpose	Electricity + Heat	Electricity + Heat	Electricity + Heat	Electricity + Heat	Electricity	Electricity
Output, kw	2300	6600	13,750	10,000	2000	2000
Fuel	Bitum. coal	Bitum. coal	Bitum. coal	Brown coal	Peat	Slurry
Lower heating value, Btu per lb	13,500	12,400	13,100	4500	5200	5900
Turbine-inlet temperature, deg F	1220	1255	1290	1255	1220	1220
Turbine-inlet pressure, psig	370	355	435	400	405	405
Heat production, normal, Btu per hr	7×10^6	26×10^6	65×10^6	...	...	...
Heat production, maximum, Btu per hr	12×10^6	55×10^6	85×10^6	32×10^6	...	...
Air heater tube dimensions, mm	32×2.5	32×3.25	32×2.75	40×4	$1^1/_4'' \times 0.1''$	$1^1/_4'' \times 0.1''$
Number of combustion chamber tubes	136	320	2×240	320	160	160
Specific release, Btu per cu ft per hour	0.0165×10^6	0.0126×10^6	0.0154×10^6	0.0140×10^6	...	...
Combustion-chamber diameter, meters	3.2	5	2×4.65	5.8	3.24	3.24

Table 2 Number of Interruptions of the Ravensburg Plant

	1956	1957	1958	1959	1960
Operating hours.....	3246	8885	13531	18444	24650
Cause of Interruption:					
Machine group.....	4	0	0	0	0
Air heater.....	11	1	0	0	0
Charging installation....	2	3	0	0	0
Total	17	4	0	0	0

mostly with peat. The air-heater design is shown in Fig. 3.[4]

Based on the favorable results obtained with the John Brown test turbine it was decided to build a 2000-kw unit, the first industrial closed-cycle gas-turbine plant, at Ravensburg. This was a joint venture of Escher Wyss, the Gutehoffnungshütte, Sterkrade, and KSG, Kohlenscheidungsgesellschaft, Stuttgart, Fig. 2.

The power plant is extensively automated and requires only one man per shift for supervision, with another man as general help, for such work as cleaning, emptying ash buckets, and the like.

Restart After Shutdown

The plant is shut down weekends, although in cold weather it is sometimes kept running then to provide room heating, thus eliminating the need for separate heat apparatus. In summertime the demand for electric power is very low at night and the plant was shut down every evening for a period of 3 months in 1958. Restarting in the morning was effected in about half an hour. An inspection of the entire plant after this period showed all elements in perfect condition. The cycle was absolutely clean and the air-heater tubes had no slag deposits or signs of corrosion. There was no trouble with the air heater nor with any other element of the plant. Both temperature distribution in the tubular heating system and the inlet temperatures to the turbine of 660 C could be kept constant even under fast changes of the load.

From cold condition after longer shutdown periods, restart is made in about 2 hr since there is no need for a shorter time. Starting time is dictated by the relatively thick brick wall of the combustion chamber. After about 18,000 hr of operation in 1959, official trial tests were carried out which show that expectations concerning efficiency at various loads have been fulfilled, Fig. 4.

The regulation of the closed-cycle gas turbine was also the subject of extensive tests. The control and self-regulating properties will be elaborated upon. They are

[4] Adapted from J. B. Bucher, "The Use of Low-Grade Fuels in Gas Turbines," International Peat Symposium, Dublin, Ireland, 1954.

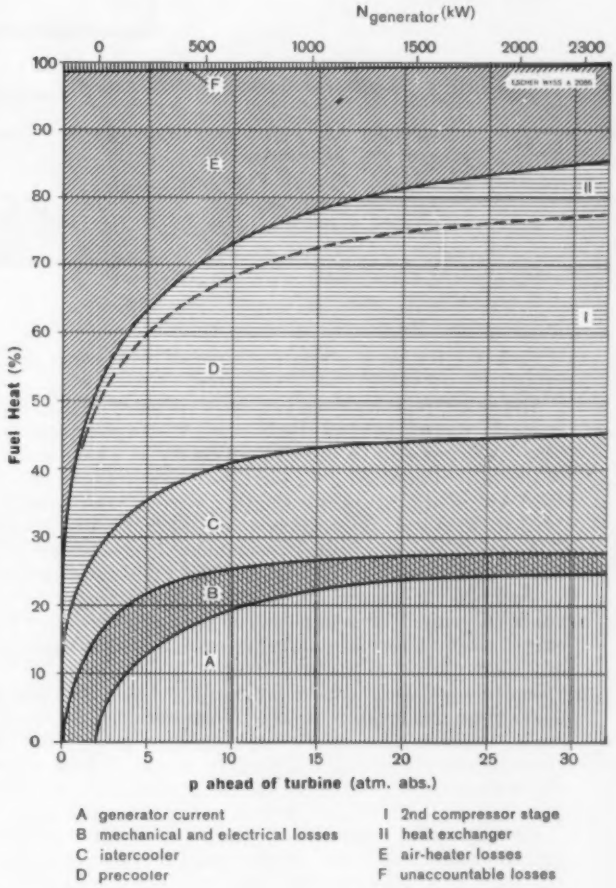


Fig. 4 Above Heat-balance diagram for various outputs, showing the flat trend of the efficiency curve. A large portion of the heat transferred to the precooler and the intercooler can be utilized for area heating, without affecting the efficiency of the generator terminals and without reducing the output.

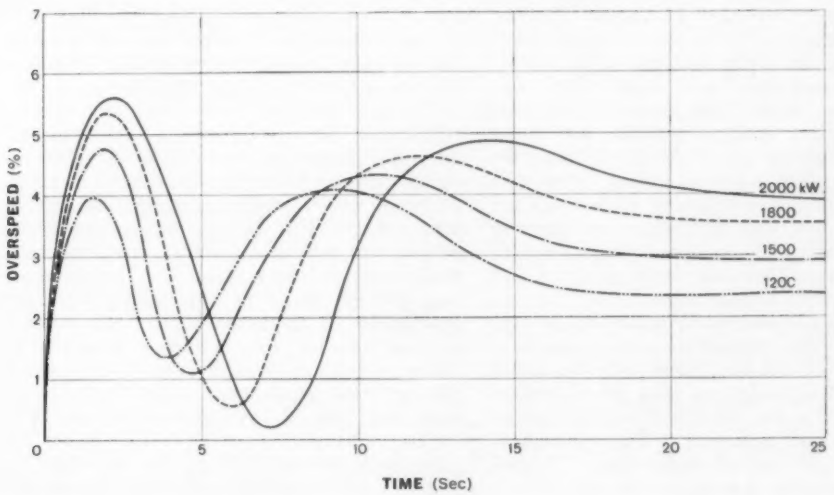


Fig. 5 Left Some measured speed increases at various load changes. The permanent speed increase is adjusted to 4 per cent. Only two speed oscillations occur at all load drops, principally because of the special Escher Wyss acceleration governor.

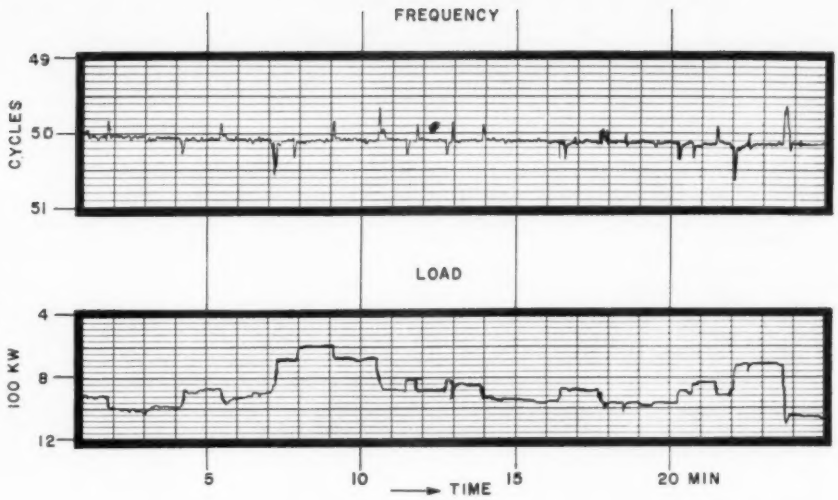


Fig. 6 Frequency and load with isostatic regulation. Frequency remains relatively constant with only short and very small variations—not more than 0.4 cycle while loads of ±400 kw (±20 per cent of full load) are switched on and off.

remarkable for such a relatively small unit with coal firing.

The plant was designed not only to work in parallel with the electric grid of the Energie-Versorgung Schwaben, EVS, but also to run independently as a sole source of the current needed by the factory. An average of about 1500 kw is needed during the day with a peak load of 1800 to 2000 kw, as contrasted to a peak load of about 700 to 800 kw at night. Load fluctuations are rather heavy and abrupt (±200 kw). The regulating device is designed for sudden and unexpected interruptions in the EVS grid. The plant then adjusts automatically to supply only factory requirements and does this without any interruption of power delivery.

In case of a load increase, air is injected into the circuit to increase the pressure level. When the load decreases air is discharged to decrease the pressure level. While the temperature of the working air at the turbine inlet always remains constant (in the range of ±5 C), the output changes in direct proportion to the pressure level.

For economic reasons the regulating device was designed to act as follows. If the plant is connected with the EVS grid where no big load increases are to be expected, then the output is raised in such a way that a low-pressure charging compressor pumps air into the low-pressure side of the circuit. If on the other hand, the plant is supplying only the factory where bigger unexpected load increases occur in a short time, then high-pressure air is discharged from an air accumulator into the circuit before the turbine. In this way large load peaks can be regulated quickly. Load drops are also regulated quickly with a bypass valve. Thus it is possible to keep the frequency constant within ±2 per cent = ±1 cycle even if large load fluctuations occur in the factory requirements. The accumulator is charged by having a high-pressure charging compressor take air from the high-pressure side of the circuit.

Some measured speed increases at various load changes are shown in Fig. 5. The permanent speed increase is adjusted to 4 per cent. At all load drops only two speed oscillations occur, and it is obvious that the steadiness of the regulating device is due principally to the special Escher Wyss acceleration governor. The permanent speed increase can be adjusted at convenience. A very efficient temporary restoring system permits the closed-cycle gas-turbine plant to operate also with an isostatic regulation. This is important when only the factory is being supplied. A record of isostatic regulation is shown in Fig. 6. The frequency fluctuations were not more than 0.4 cycle while loads of about ±400 kw (±20 per cent full load) were switched on and off.

Two overspeed trips (one hydraulic, one mechanical) work in parallel to insure that the maximum overspeed of 10 per cent will never be exceeded. These overspeed trips act directly on the quick-closing device.

Air-Heater Design

Since this is the first industrial gas-turbine installation burning pulverized coal, the layout of the air heater is rather conservative as regards specific combustion-chamber loading and tube stresses. This is also true of the recently built larger coal-fired air heaters listed in Table 1. This table also gives the main data for the radiation section of the air heaters. The main temperatures and pressures in the Ravensburg air heater are given for 2000-kw load in Fig. 7.

The Ravensburg air heater, the first for bituminous coal, is shown in cross section in Fig. 8. The air heater of the Moscow plant for brown coal, which started operation in September, 1960, is shown in Fig. 9. The erection of the tubes of one combustion chamber of the Oberhausen plant is shown in Fig. 11. The accessibility of the single row of tubes is remarkable.

It is gratifying to report that the operating difficulties of air heaters for closed-cycle plants were exaggerated. As in the case of steel-tube heaters for chemical or refinery plants for high temperatures, the prejudices of steam-boiler designers had to be overcome first. Actually heater design and operation probably offer fewer problems for high-temperature service than modern steam-boiler practice. The relatively low-pressure level of closed-cycle turbines permits tube-wall and collector-wall thickness to be kept small and reduces thermal stresses. Only a fraction of the total heating surface is built in austenitic steels. In the existing plants no very high grade steels above 16 Cr-13 Ni type have been used. At present, the over-all size of an air heater differs little from a corresponding boiler, because main dimensions are dictated by the necessary burning time and the path of the coal particles. Experience has shown

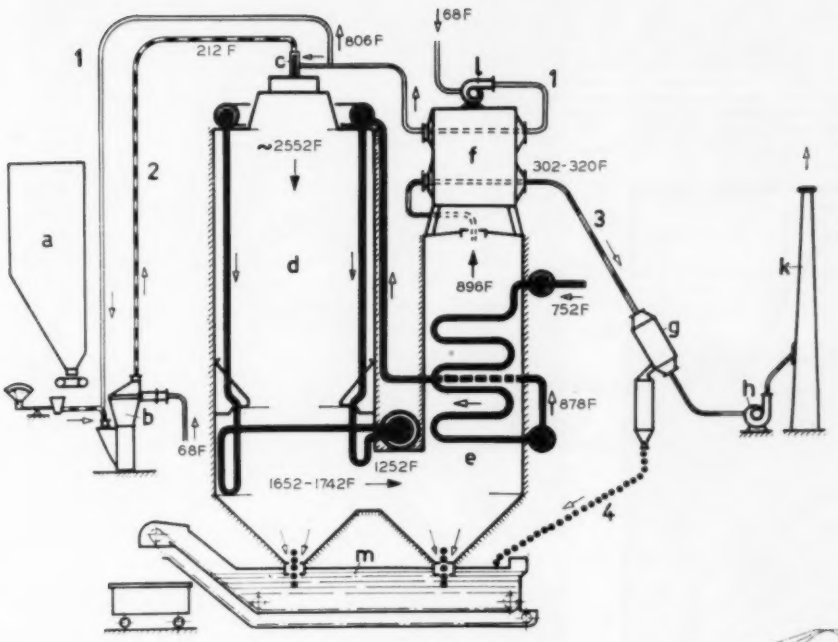
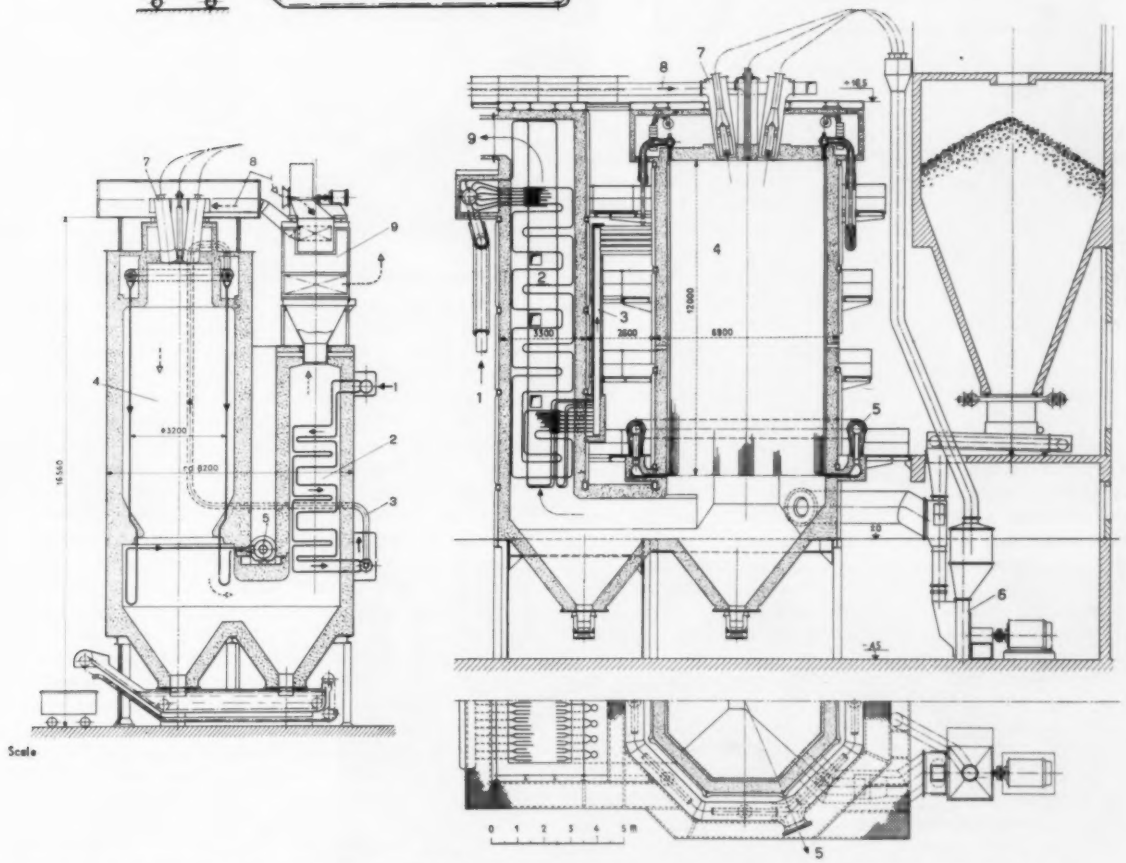


Fig. 7
Schematic of the Ravensburg air heater, showing the principal temperatures:
1—combustion air
2—pulverized coal
3—flue gases
4—ash
a—coal bunker
b—coal mill
c—burner
d—combustion chamber
e—convection chamber
f—combustion-air preheater
g—ash separator
h—flue-gas fan
k—chimney
l—combustion-air fan
m—ash extractor

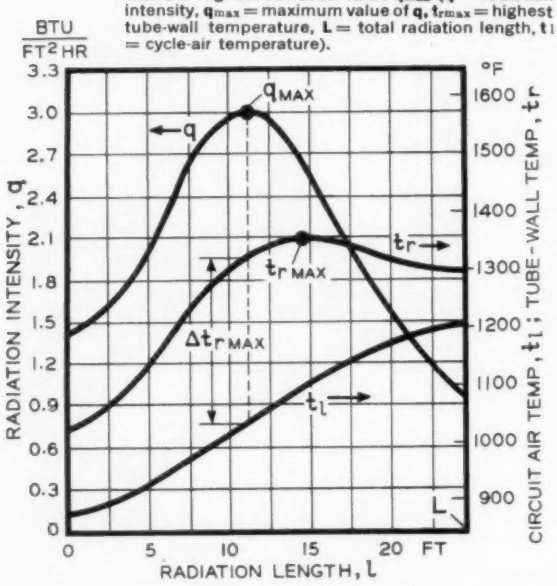


(**1**—from heat recuperator, **2**—convection section, **3**—connection tubes, **4**—combustion chamber (radiation section), **5**—to turbine, **6**—coal mill, **7**—burner, **8**—combustion air, **9**—combustion-air preheater)

Fig. 8 The pulverized-bituminous-coal-fired air heater for the 2000-kw Ravensburg plant in cross section.

Fig. 9 The pulverized-brown-coal-fired air heater for the 10,000-kw Moscow plant in cross section.

Fig. 10 Design data for the radiation portion of the Ravensburg air heater. At any load, the highest tube-wall temperature does not exceed the maximum air-inlet temperature of the turbine by more than about 80 C. Furthermore, the highest temperature of the tube wall $t_{r\,max}$ does not coincide with the highest radiation value q_{max} (q = radiation intensity, q_{max} = maximum value of q, $t_{r\,max}$ = highest tube-wall temperature, L = total radiation length, t_l = cycle-air temperature).



that combustion of pulverized coal of different qualities is very good. In an air heater the temperature of the preheated combustion air is higher than in steam boilers (about 750 F) and combustion wall temperatures of the radiant section are also higher than in a steam boiler. This helps to create ideal combustion conditions. Therefore even small-capacity air heaters may work perfectly. For example, the Ravensburg plant can operate at part load—down to about 400 kw—on coal only, without supporting flame of any kind.

At any load the highest tube-wall temperature does not exceed the maximum air-inlet temperature of the turbine by more than about 80 C, Fig. 10. This figure also shows that the highest temperature of the tube wall $t_{r\,max}$ does not coincide with the highest radiation value q_{max}. This is believed to be an important feature of today's air-heater designs. If for any reason the flame should be shorter than assumed in design, then the highest radiation value q_{max} is more on the left side of the diagram, that is, nearer the top of the combustion chamber at lower cycle air temperature, so that the tube-wall maximum temperature also moves to the left but, due to the bigger temperature difference Δt_r, practically without change of the value.

Conversely, if for any reason the flame is longer than anticipated in the heater design, then the maximum radiation value is more on the right side of the diagram; but, because of the longer flame, the highest value is correspondingly reduced so that the maximum tube-wall temperature remains practically unchanged. For these reasons, today's heater design offers adequate margin when dimensioning the tubes in the radiation chamber, even if the burning characteristics of the fuel are not known in detail. Escher Wyss heaters are designed for a life of about 100,000 hr at full load. Stresses in tubes are low (about 28 psi).

Since there is no fluid in the air heater, it can be erected outdoors without danger of damage from freezing. Building costs are therefore reduced.

In Europe, and as far as is known in the U. S. also, an economic gas-heater design is prevented by application of boiler-code practice. The resulting design is too heavy and expensive, and without technical reason. Design recommendations for chemical heaters are much sounder. In Europe thin-wall alloy tubes can be applied, since it has become obvious that working conditions are very different from those in boilers. No danger of explosion exists. Costs of European-built gas heaters are, therefore, much smaller than those planned in the U. S. It is felt that application of existing requirements from an old field in a new development bans progress.

Low cooling-water requirements and simplicity of operation of isolated self-controlled plants will bring about more and more applications of closed-cycle gas-turbine plants in remote areas. Experience shows that the air heater can use low-grade fuel without difficulty. For self-contained plants with widely variable load, the variable pressure-regulation system applied in closed-cycle systems leads to high efficiencies not only at full load but also over a wide power range, as compared with open-cycle gas turbines, where the efficiency falls rapidly at reduced loads. Furthermore, as the load is independent of the ambient air temperature, the nominal load is available in winter as well as in summer and only the plant efficiency depends on the cooling-water temperature, which varies less than the ambient-air temperature. This is different with the open-cycle gas turbine, where the maximum load is considerably reduced in summer.

This fact has to be considered when evaluating the over-all economy of the plant. For example, the measured efficiency of the Ravensburg installation is shown in Fig. 4. For bigger units both maximum efficiency and part-load efficiency will be appreciably higher.

Power and Heating Combinations

Most of the coal-fired plants mentioned in Table 1 are used as combined power-production and central-heating installations. As the cooling water from precoolers and intercoolers of the cycle can be made available at about 190 F, a unique heat source at convenient temperature level is provided for different industrial or domestic purposes. It should be noted that, in contrast to steam plants, heat extracted from the closed cycle at the aforementioned temperature is pure waste heat. By properly using the heat from coal for both electricity and heat production, the over-all efficiency can be raised to 60 or 70 per cent. Central-heating schemes using waste heat are fast spreading in Western Europe and Russia. For combined power-production-and-heating systems small and medium thermal power plants are best. Central heating is only economical when the distance of users from the power plant is not too great. In general, 1 kw installed may cover the needs of about one worker in industrial plants (Ravensburg 1800 kw for 1800 people). About the same amount (1 kw or about 3400 Btu per hr) may be consumed for heating purposes. Therefore a closed-cycle plant of say 25-mw electrical output will cover the needs of about 25,000 people with their families.

Erection in the Escher Wyss works of the machinery for the 10,000-kw Moscow plant is shown in Fig. 12.

The machine room of the 2000-kw Rothes plant which burns slurry is shown in Fig. 13.

The machine set at the Oberhausen plant which began operation in October, 1960, is seen in Fig. 14.

The COAL-BURNING Closed-Cycle Gas Turbine

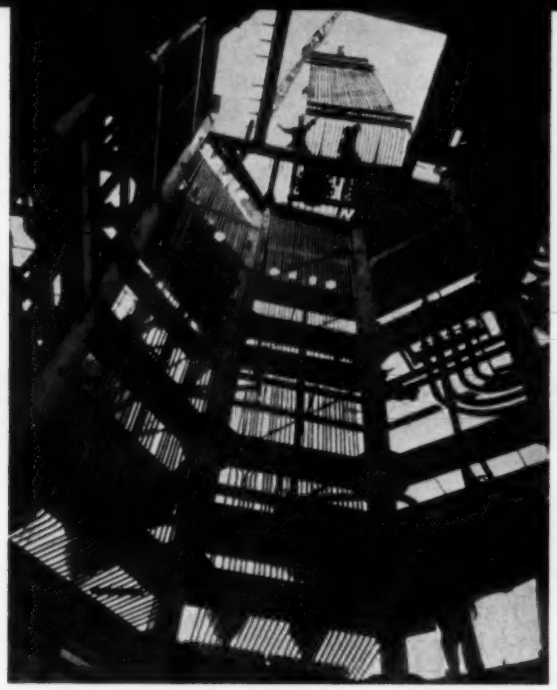
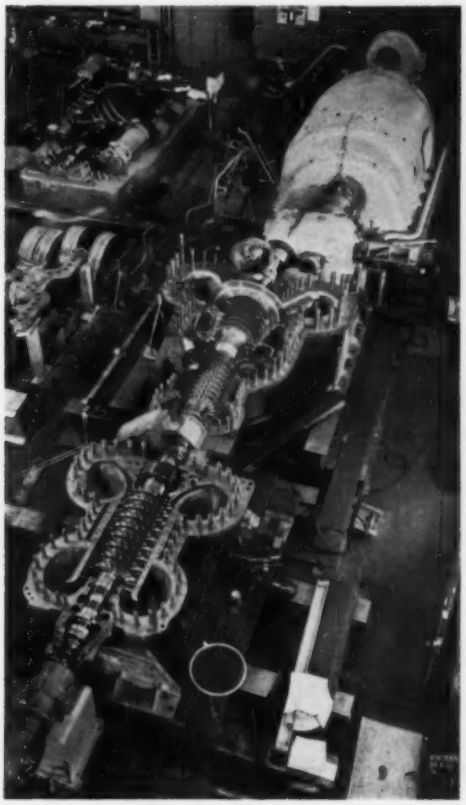


Fig. 11 Left Each of the two combustion chambers of the Oberhausen gas-turbine plant has a single row of tubes, providing remarkable accessibility

Fig. 12 Below The 10,000-kw Moscow plant under construction at the Escher Wyss works



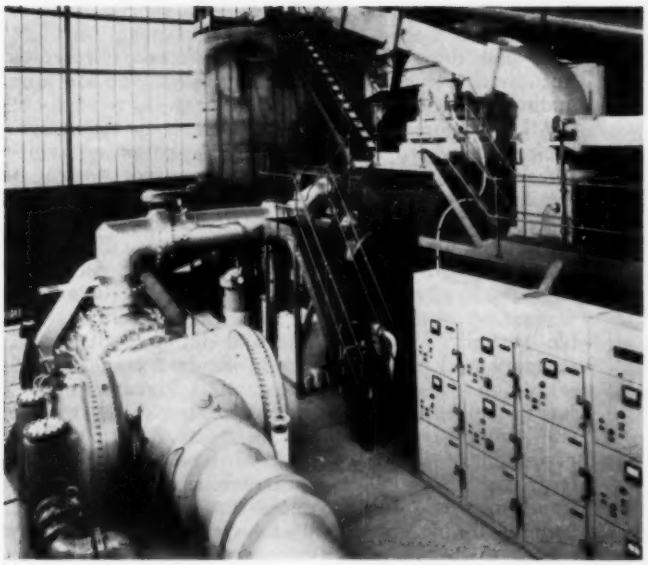
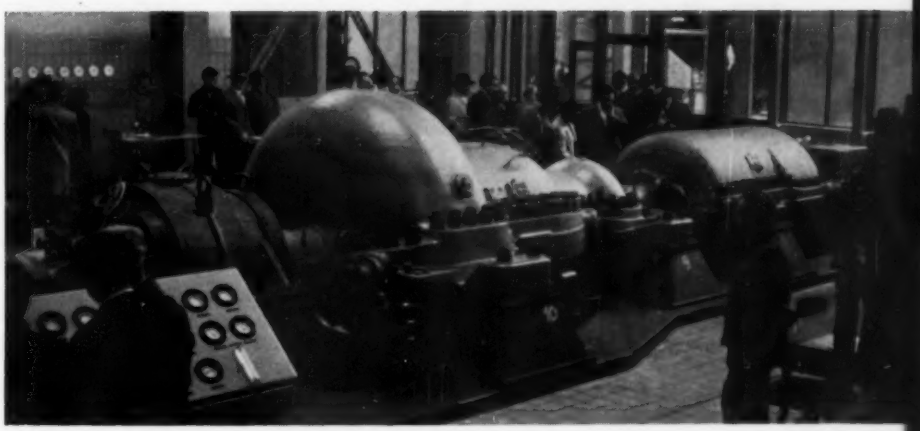


Fig. 13 Above Machine room of the 2000-kw closed-cycle gas-turbine plant at Rothes, England. The plant is fired with a slurry of low-grade coal.

Fig. 14 Right The 13,750-kw machine set for the Oberhausen plant, which began operation in October, 1960, similar to the machine set of Fig. 12



BI-

By Dan Christopher

Gray Tool Company,
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BIMETALLIC pipe was first used in 1870 when Isaac Smith was granted a patent on lead-encased tin pipe to control erosion. Many kinds of bimetallic pipe are now made by a variety of methods. Each is suited to some particular applications, but no one may be considered a panacea for all corrosion problems. Of these materials, cold-drawn bimetallic tubing is probably the best known because of its extensive use in condenser and heat-exchanger service. Large sizes of pipe made from clad sheet or plate are also quite well known.

Beyond these common piping materials, steel pipe lined with Strubing and cast bimetallic pipe are now finding specific applications.

All of the foregoing materials possess some mechanical limitations that prevent them from obtaining widespread acceptance. Economic considerations, such as minimum quantities for production schedules, time required for delivery, size, and available materials, have restricted some materials as well.

In the type of product to be discussed, a lining material is hydraulically seated into a base pipe. This system utilizes the most inexpensive and the most readily available material for both base and lining. Generally, standard steel pipe is the base in standard pipe sizes and schedules. The lining for the small sizes is usually seamless or welded thin-wall alloy tubing; and in the large sizes, linings welded from alloy sheet. The completed product, made in this way, is low in final cost and usually is promptly available. The combination of base and lining materials is as flexible as the availability of the base and lining stock, and at present the size range is from 1 to 20-in-diam in every standard wall and lining thickness desired.

In the method of manufacturing bimetallic pipe used by the author's company, a relatively thin lining of alloy material is hydraulically expanded into a base pipe. With the correct selection of the initial diameters of the base and lining materials, and by proper application of pressure, the lining expands with a uniform yield until it just contacts the base pipe. Pressure beyond this initial level, elastically expands the base pipe and continues the plastic expansion of the lining. After the final pressure is released, the elastic contraction of the base material actually exceeds that of the contraction of the lining material; thereby holding the lining tightly in place and effectively applying a slight compressive force, see Fig. 1.

If the initial seating pressure is not sufficient to produce

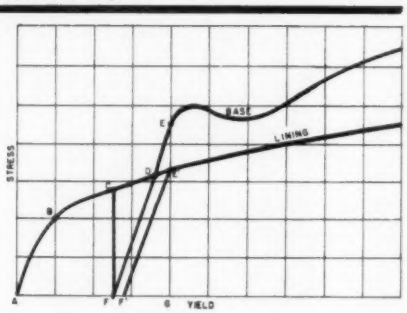

Fig. 1 Stress-strain diagram for a typical combination of materials. The lining follows its normal stress-strain curve as it expands and passes into the area of plastic yield **A, B, C.** With increased pressure the lining just contacts the base material at **C.** With continued increase of pressure the base also expands elastically and the lining continues plastic expansion. If the base has a higher yield strength than the lining, its curve will eventually cross that of the lining material. At **D** where the two cross, each has the same effective strain and stress and the lining is tightly in contact with the base, and they will remain in the same relative condition for any lesser amount of pressure. If additional pressure is applied, both will further expand to **E** and **E'.** Upon releasing the pressure, both will return to 0 stress, the base springing back the distance **FG,** and the lining **F'G.** Since **FG** is larger, the lining will be in compression the amount represented by **FF'.**

Table 1 Tensile modulus of elasticity and yield point

Material	Modulus of elast., × 10^6 psi	Yield point
Aluminum	10	4,000
Zirconium	11	16,000
Titanium (A-40)	17	40,000
Copper	17	12,000
Monel	26	35,000
Tantalum	27	30,000
Stainless-steel (Types 304, 316, 321, 347)	28	35,000
Steel pipe (A-53)	30	35,000
Nickel	30	20,000
Inconel	31	30,000

Table 2 Coefficient of thermal expansion

Metal	In./In./deg F × 10^{-6}
Tantalum	3.6
Titanium	4.7
Inconel	6.4
Steel (Pipe A-53)	7.2
Nickel	7.4
Monel	7.8
Stainless-steel Type 316	8.9
Copper	9.2
Stainless-steel Type 321	9.3
Stainless-steel Type 347	9.3
Stainless-steel Type 304	9.6
Aluminum	13.3

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Corrosion resistance, strength, economy: These may call for bimetallic pipe. This is a report on one of the bimetallic products—its fabrication, its strength, its heat transfer.

METALLIC PIPE

a stress in the base pipe that is equal to the stress in the lining, then the lining will never be completely tight. Conversely, any additional stress in the base beyond that in the lining will be an assurance of a tightly lined finished product.

Differences in the modulus of elasticity will have some effect on the resultant product. Most of the alloys and materials used in making bimetallic pipe have a modulus of elasticity ranging from a low of 25×10^6 to a high of 30×10^6, Table 1. This relatively small difference from one metal to another will have little effect on the ability of the material to either stay tight or become loose when it forms a lining. Four metals, however, have considerably lower moduli of elasticity. These are copper, aluminum, titanium, and zirconium. With these metals, the slope of the stress-strain curve in the elastic range will make a slight difference in the tightness of the lining.

If low modulus of elasticity is coupled with a low yield point (as in aluminum and copper) the springback will not be serious. On the other hand, a low modulus coupled with a high yield point will require careful control. To overcome the springback, heating to reduce yield strength can be effective.

Whether this piping material is drawn through a die, ball expanded, rolled, or hydraulically expanded, these same fundamental premises must be held in order to achieve a tight assembly.

In operation, the pipe will stay tightly in contact with the base if: (*a*) There is a positive pressure differential between the inside and the outside, and/or (*b*) the inside temperature is greater than the outside.

Of course, the differential in the thermal expansion will have something to do with this tightness over any temperature range, but this difference, again, is of a very small order, Table 2. Between copper and steel this represents approximately 0.0000002 in. per in. per deg F. With a temperature change of 100 F, a copper-lined pipe 3 in. in diam could become loose by 0.00006 in. or tighter by the same amount, depending upon whether the temperature range moved higher or lower from that at which the product was manufactured. This factor can exist only if there is no residual compression in the manufacture.

This variation in thermal expansion takes on greater significance in analyzing the possible effect in endwise expansion and contraction. The longest pipe that it is now practical to make with this system would be a double random length or approximately 40 ft, and it is impossible to project this differential from one joint to another. Each joint of pipe would have the lining clamped or sealed by welding at the ends; therefore axial movement of the lining cannot be transmitted along the line from joint to joint. If a temperature change of 1000 F were applied to a 20-ft length of pipe, the variation in expansion of one piece could amount to 0.48 in.

If the lining were free to move axially, such an expansion or contraction might cause some trouble in the operation of the piping system. Counteracting this thermal force, however, is a frictional component which will take care of the thermal stress by converting it into a tension or compression stress.

In the author's experience, no relative movement has been noted in examining the cut ends of pipe that have been heated in bending. A careful check was made of 16-in-diam pipe in 24-ft-long joints that were heated in the center to 1950 F. Even under these severe conditions, the lining adhered tightly to the pipe.

Effect of Pressure

From applied pressure and strain measurements, it is known that the lining material adds considerably to the over-all strength of any base pipe. It will be stronger in the resistance to internal pressure and will also be stronger in the resistance to normal bending forces. The Code, however, does not recognize this additional strength consideration, and any calculations regarding pressures shall be based upon the characteristics of the base pipe (the material from which it is made, and the wall thickness).

What About Heat Transfer?

It would be unreasonable to assume that two pieces of metal squeezed together in any way would possess equivalent heat-transfer properties to that of solid metal. In general, if the heat-transfer characteristics of each, the base and the lining material, are drawn on one chart, the heat-transfer characteristics of the bimetallic pipe lie between these two curves.

The first limitation, besides the characteristics of the metal, in obtaining effective heat transfer is the matter of contact between the base and the lining. Even with proper manufacturing technique, good contact can only be effected if the surfaces are clean. Certainly, contaminants of any sort, including oxides, may possess poorer heat-transfer properties than the base or lining.

Probably the most important factor influencing the total contact is the surface roughness of the tubes. If the mating surfaces have irregularities of considerable magnitude, 100 per cent contact is impossible. If the surfaces are mirror bright and vary 10 microin. or less, the contact area should be very good, but under no condition will it be 100 per cent. Heat transfer by conduction will

Fig. 2 For an effective butt weld, the lining should extend beyond the bevel of the pipe by about 1/16 in. This may be achieved by machining the bevel in a lathe or by using a parting-type cutter. Some handwork may be required in removing the final traces of steel so that the lining itself is not damaged.

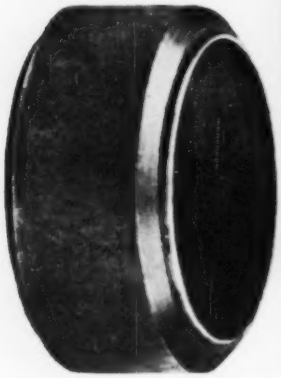
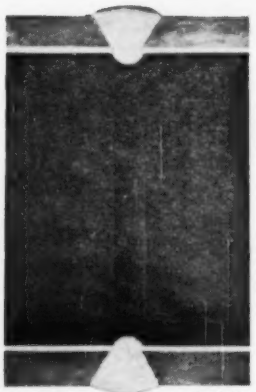


Fig 3 To make a butt weld, the two pieces of pipe with projecting lining are properly aligned and the seal pass is made either by straight fusion welding with inert-gas equipment or by inert-gas welding with a filler wire of the same metal as the lining.

Extreme cleanliness is most important to eliminate contamination from slag, dirt, and so forth. The inside of the pipe should be purged with nitrogen or a fully inert gas such as helium

Figs. 4, 5 After the seal pass is made, an inert-gas bimetallic welding technique may be used to fuse the lining to the base pipe. After sufficient deposit to insure against porosity, it may



be completed by the electric-arc method. A bimetallic rod such as Inco A is frequently most successful for nickel-base alloys.

be a function of the amount of contact, plus the transfer by radiation across the areas not in contact. It has been suggested that to improve heat transfer this interface section should be bathed in a low-molecular-weight gas, such as helium, or possibly even a third metal, such as tin, which might be liquid under some temperature conditions. Actual test data are limited, and the matter may be worthy of further investigation.

Actually the film coefficient of heat transfer may be greater than the total conductivity of the tubes, and the fouling factors that exist in many heat exchangers further reduce this loss to the point of insignificance. In some installations the ability of the bimetallic tube to resist corrosion and fouling has actually improved the over-all heat transfer of some equipment.

What Kind of Metals Can Be Used?

Bimetallic pipe attempts to save money by substituting low-priced base material (carbon steel) for high-priced alloy. If the environment will tolerate standard seamless carbon steel, ASTM A-53 is most frequently selected as a base. To meet more difficult environmental conditions, the base requirements are sometimes more stringent than those for the lining.

For lining materials, there is a wide choice. From the manufacturing standpoint the best would be a soft, inexpensive, no-yield-point product such as lead, but, unfortunately, such material seldom meets the needs of the user. Therefore those that are most popular are the alloys of copper and nickel, ranging from pure copper to pure nickel. These materials do not embrace all of the corrosion-resistant properties desired in some cases, so that the austenitic stainless steels are next in order of demand. Experimental work is being carried out with titanium, tantalum, and zirconium, each of which holds considerable promise for future needs.

The use of the least amount of expensive material practical represents the second objective in saving money, but extremely thin linings cannot be used in many applications, and the cost of the lining material per foot is by no means directly proportional to its thickness. In pipe sizes 2 to 6 in., linings of 0.035 in. now represent a combination of an economical and a practical minimum, offering adequate corrosion protection and sufficient mechanical strength for most conditions. Linings may be reduced to 0.010 in. if the finished product does not have to be welded, and they have been as heavy as 0.078 in. for pipe up to 16 in. diam.

Pipe sizes up to 4 in. can usually be furnished with seamless linings; and in sizes 4 in. and larger, welded linings are required. If a very thin lining is required, regardless of the diameter, a welded material represents about the only thing currently available.

Fabrication of Bimetallic Pipe

Bimetallic pipe fabrication is the same as that for carbon-steel pipe, with some minor refinements. Pipe bends from 5 to 8 diameters can readily be made. Expansion loops and large-radius bends in small sizes of pipe can frequently be made cold, but in large pipe and in heavy-wall sections, the pipe must be heated prior to bending. Heated bends are sand-packed and the normal precautions for bending pipe for the particular size involved should be followed. Special care must be taken with some metals, and the bending characteristics of the lining as well as the base pipe must be considered if the lining is not to be damaged during the bending operation.

Welding fittings, such as ells, are now only obtainable in solid alloy in small sizes. Large sizes may be individually strip lined, but a full-lining system for both ells and tees is being developed. To reduce the expense of fittings, particularly in large sizes, miter bends and "stab-in" tees are most easily made, and are quite effective unless pressure drops or high velocity requirements preclude their use.

Lined pipe may be effectively butt welded. The welding procedure will vary to some extent with the type of lining used and the size. The most effective butt weld will be one in which there is no possible contamination of the seal weld of the lining by the base material. This is most easily achieved by allowing the lining to extend from the bevel of the pipe by about $^1/_{16}$ in., Fig. 2.

For the irregular shapes used for stab-ins, Y branches,

Figs. 6, 7 Where wall thickness is irregular, or for such applications as stab-in tees, it may not be practical to line up the extended lining. The ends of the bevel are first buttered to make a seal between the end of the pipe and the lining material. A filler of the same metal as the liner is required. The pipe elements are then aligned and the weld is finished as before.

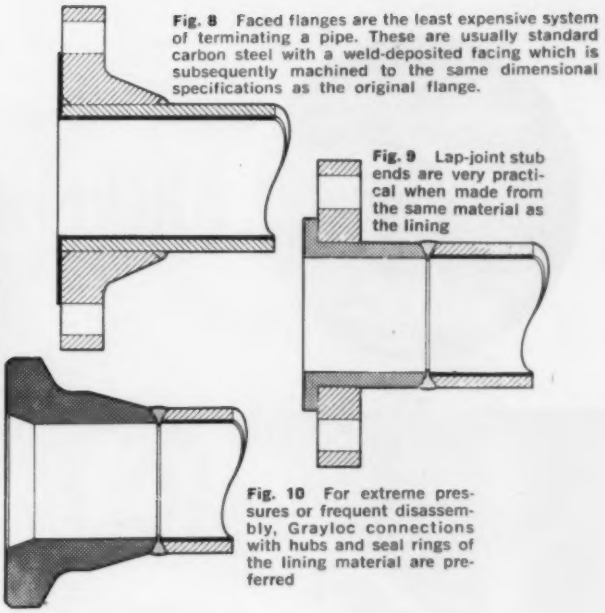


Fig. 8 Faced flanges are the least expensive system of terminating a pipe. These are usually standard carbon steel with a weld-deposited facing which is subsequently machined to the same dimensional specifications as the original flange.

Fig. 9 Lap-joint stub ends are very practical when made from the same material as the lining

Fig. 10 For extreme pressures or frequent disassembly, Grayloc connections with hubs and seal rings of the lining material are preferred

and so forth, flame cutting may be effectively used. Arcair is often used for both lining and base pipe, but the weld bevel must be made with the oxyacetylene flame, to leave the lining protruding in the same manner as specified in the lathe cut.

In making the butt weld, the two pieces of pipe with the lining projecting are properly aligned, and the seal pass is made either by straight fusion welding with inert-gas equipment or with inert-gas welding with a filler wire of the same metal as the lining, Fig. 3.

After the seal pass is made, the weld may be completed from the outside by using first inert-gas bimetallic welding technique which will fuse the lining to the base pipe. After a sufficiently thick weld is deposited to be unaffected by some slight degree of porosity, the weld may be completed by the electric-arc method. In the nickel-base alloys, a bimetallic rod, such as Inco A, is frequently most successful, Figs. 4 and 5.

If the pipe wall is irregular in thickness and for applications such as stab-in tees, it may not be practical to line up the extended lining. A successful seal weld can be made by first buttering the ends of the bevel so that a seal is made between the end of the pipe and the lining material, Figs. 6 and 7.

In large-size pipe and particularly near the ends, the procedure may be reversed, and the technique followed similar to that of welding clad sheet material from the steel side. A welded connection can be produced by either the standard electric arc or by submerged-arc welding and the seal pass made last. The strength weld must be carefully ground out and cleaned up prior to making the seal weld, which must be produced with the inert-gas method. Several methods can be used for cleaning up and routing out the groove for the seal pass, however, the lining can be contaminated by the simple grinding method that is frequently used.

In terminating a pipe, there are several readily available systems, Figs. 8, 9, and 10.

The wide range of sizes in which bimetallic pipe may be made makes quite practical the use of this material for vessels, and its availability even in limited quantities frequently enhances the delivery of such equipment.

Bimetallic pipe can be furnished with a built-in alarm, in case of trouble. Bleed or tattletale holes can be drilled through the base. These holes should be small, $^1/_{16}$ to $^1/_8$-in. diam. If at any time there is any penetration of the alloy lining, a small leak will show up.

Corrosion Resistance

As a corrosion-resistant product, bimetallic pipe has application in five specific areas of corrosion:

1 If the corrosive atmosphere can be fully or essentially controlled by a thin layer of corrosion-resisting material.

2 If the corrosion is manifest as a product contaminant, it may be much easier to prevent the pickup of the contaminant by the use of noble lining in the piping system than to try to remove it at some point.

3 If there is a dual corrosive atmosphere for which no one material is suited.

4 If a catalyst is poisoned by ordinary piping materials, bimetallic pipe might serve as a catalyst's support or as a vessel to speed up reaction.

5 Where the structural demands are greater than the alloy alone could stand.

The effective sizes in which bimetallic pipe can be made are more a problem of economics than engineering. Bimetallic pipe usually finds its greatest advantages when (*a*) pressures are high, (*b*) sizes are large, and (*c*) alloys are expensive.

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"Making the Most of Titanium in the Chemical Process Industries," Crucible Steel Company of America, Pittsburgh, Pa.

"A Summary of Physical and Mechanical Properties of Tantalum and Tantalum Alloys," National Research Corporation, Cambridge, Mass.

"Physical and Mechanical Properties of Tantalum," Defense Metals Information Center, Battelle Memorial Institute, Columbus, Ohio.

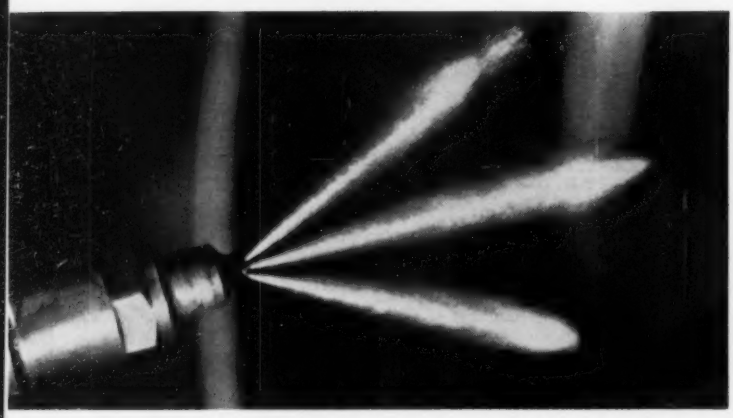
"Special Analysis," Memo 121, Superior Tube Co., Norristown, Pa.

"Design, Fabrication, and Performance of the Duplex Heat Transfer Tube," KAPL-1797, General Electric Company, Knolls Atomic Power Laboratory, Schenectady, N. Y.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Associate Editor

BRIEFING THE RECORD



Individual droplets in a high-velocity fuel-injection diesel spray can easily be seen with Strobotac. Both droplet size and range can be determined. The technique has also been used for aerodynamic studies for the visualization of flow over airfoils. The Strobotac is simply held in the hand and aimed at the spray.

Advanced Slow-Motion Analysis

THE many uses of the stroboscopic principle for the analysis of high-speed machinery and processes will be further extended with the improvements incorporated in the new Strobotac made by General Radio Company, West Concord, Mass.

The Type 1531-A Strobotac is an advanced design of the stroboscopic tachometer introduced in 1935. It uses the same basic principle of periodic illumination of whirling or moving objects to make them appear to be in slow motion when the rate of illumination is nearly equal to the rate of rotation or motion and to apparently stop the motion when the two rates are equal.

The light intensity has been increased, the flash duration shortened, the divergence of the beam has been narrowed, and the speed range of the unit has been nearly doubled.

The light intensity of the new Strobotron lamp used in the device is over 70 times as bright and it is white rather than red. Intensities are 0.21, 1.2, and 4.2 million beam candle power on high, medium, and low-speed ranges and 7 million for a single flash. The greater intensity permits effective use under normal room lighting, and finer detail can be seen with less eye strain because of the greater resolving power of the human eye for white light.

The shortening of the flash duration by a factor of 10 to 20—it is 0.8 microsec at high flashing rates—allows a corresponding increase in the upper limit of speed of the viewed object. The higher frequency range—from 110 to 25,000 rpm in three stages—permits direct measurement of 400-cycle devices.

The divergence of the beam has been narrowed to 10 deg at half-intensity points, providing almost a point source and permitting the beam to be projected into the interior of machinery.

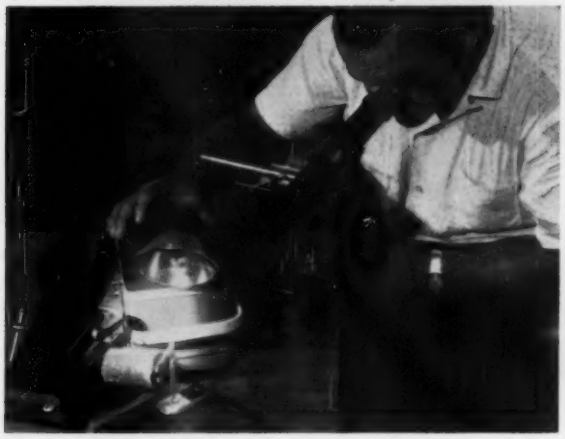
The new Strobotron lamp developed by Edgerton, Germeshausen & Grier, Inc., in co-operation with General Radio, produces its flash of white light by an electrical discharge through xenon gas. Not only is the pulse shorter but the long tail characteristic of the neon Strobotron tube is eliminated, resulting in much sharper definition of fast-moving objects. Pulse width is approximately 0.8 microsec at low intensity, 1.2 microsec at medium intensity, and 3 microsec at high! This compares with 10 and 40 microsec on the low and high-intensity positions for the old Type 631-BL Strobotac. The life of the lamp has been improved to between 500 and 1000 hr of operation before replacement is required.

The whole Strobotac unit is mounted in a new flip-tilt case measuring only $10^{5}/_{8} \times 6^{5}/_{8} \times 6^{1}/_{8}$ in., and weighing $7^{1}/_{8}$ lb on which patents are pending. Part of the case flips back and becomes a stand for the instrument. A hinged lamp assembly swings 180 deg vertically and 360 deg horizontally for easy aiming.

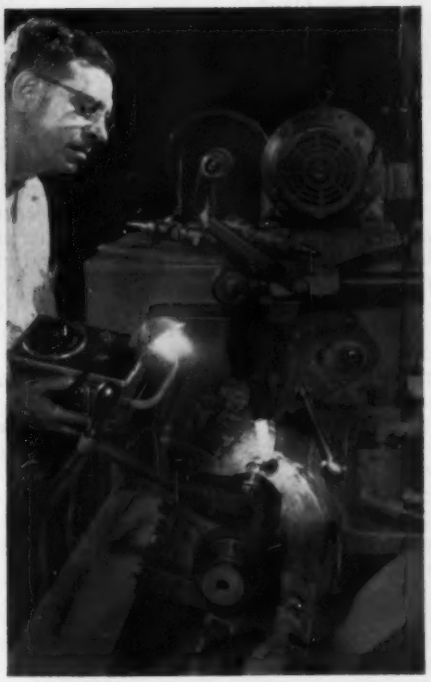
The unit operates on 105–125 (or 210–250) volts, 50–60 or 400 cycles with 35 watts input. It is accurate to within 1 per cent of the dial reading after calibration in the middle range.

A rapidly oscillating rod can appear to be "stopped" or its motion "blurred" by changing the rate of flash. Various phenomena can be observed while the rod is in high-speed operation.

The complex actions involved in the spiral wrapping of tires, steel coils, rugs, and other materials are monitored and the speed of the operation is checked at Pierce Wrapping Machine Company. Ordinary illumination does not interfere because of the intensity of the flash.

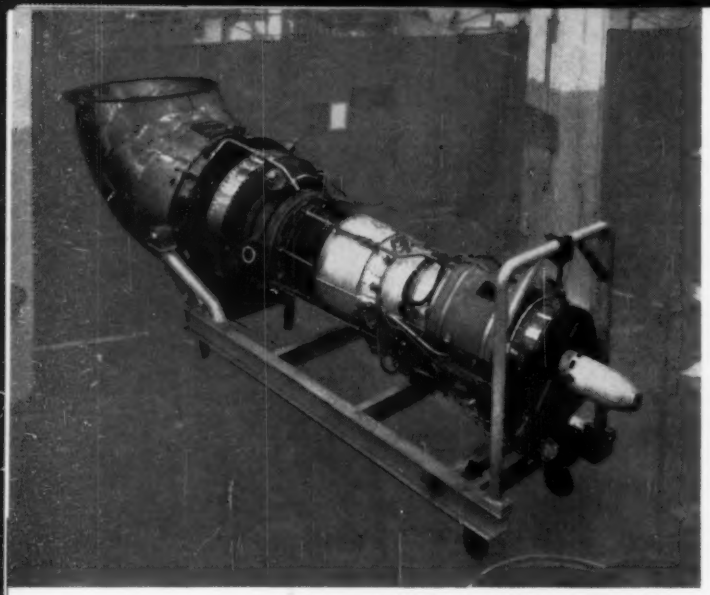


A new flip-tilt carrying case doubles as an adjustable stand for Strobotac. The light beam of the unit can be rotated 360 deg horizontally and 180 deg vertically.



At the Norton Company, the operation of an automotive cam-shaft grinder is checked. It is desirable to grind at high speed for the best possible finish of the cam surfaces, but for safety reasons the wheel should not be operated above its rated speed. Strobotac's flashing-rate stability and 1 per cent accuracy make it possible to hold circumferential velocity of the Alundum vitrified wheel to an exact pre-established point below rated speed.

Vibratory modes in aircraft gas-turbine blades are studied by Strobotac at the General Electric Small Aircraft Engine Department. Mode shapes are clearly defined at the various excitation frequencies that are produced by an electromagnetic driver. Other applications are the dynamic balancing of rotors, the study of slip between friction-drive members, determination of the speed at which the jaws of centrifugal clutches begin to open.



An aircraft jet engine—GE Model 240—has been converted for use on an experimental hydrofoil craft being built by the Maritime Administration

Aircraft Jet for Marine Use

THE Model 240 turboshaft engine, a modified version of General Electric's J79 turbojet engine which currently powers four types of military Mach-2 aircraft, will be installed in the Maritime Administration's experimental hydrofoil craft this summer. Foils attached to the sides of these craft cause the hull to lift out of the water, reducing the displacement resistance (MECHANICAL ENGINEERING, June, 1959, pp. 48–53).

Various configurations of the turboshaft engine and exhaust system are also planned for use in mobile electric-power systems for remote or emergency uses, and as prime movers for peaking power generators. The unit's lightweight, high-power characteristics make it ideally suited for such selected industrial and electrical applications.

This new marine engine consists of the basic gas generator used in the J79 turbojet, plus an aftmounted power turbine that converts high-velocity jet exhaust into shaft horsepower. As a comparison, in a jet plane, jet-engine exhaust causes a reactive thrust that powers the aircraft. In the hydrofoil craft, a windmill-like turbine harnesses jet exhaust to drive the craft's screw propeller. The Model 240 engine will power the Maritime Administration hydrofoil at speeds up to 60 knots.

The 104-ft craft is being built by Dynamic Developments, Inc., an affiliate of the Grumman Aircraft Corporation.

Though General Electric has produced marine propulsion systems for more than 50 years, the J79 turbojet is the first large jet engine to be converted to seaduty. Like the J79, the Model 240 turboshaft engine has a very favorable power-to-weight ratio, fulfilling hydrofoil craft requirements for a lightweight, compact, high-performance power plant.

The J79, America's first Mach-2 turbojet, delivers more thrust per pound of engine weight than any other turbojet in its class.

Later versions of the Model 240 turboshaft engine will use the gas generator from the Company's CJ-805 turbojet in place of the J79 gas generator. The CJ-805 engine is the commercial version of the J79 turbojet. It is now in regular airline service powering the Convair 880 jetliner.

Dust-Free Handling

A BULK-MATERIAL conditioner developed by the Johnson-March Corporation, Philadelphia, Pa., permits dust-free handling of powdery, finely divided materials. The material conditioner, called Verticone, will handle dusts from all types of collection equipment. It makes bagging operations, loading and unloading from bins, silos, ships, trucks or rail cars, and especially dust-collector bins dust-free.

Dust is suppressed by adding a precisely controlled amount of moisture (as little as 1 per cent) into the finely divided material, providing controlled wetting of all the surfaces of each particle with an extremely powerful surface-active compound, called Compound MR.

Rapid and effective conditioning is obtained by proper dispersion of the solid stream of material. This is accomplished by introducing the material onto a distributing cone at the top of the Verticone. The material falls over the cone and leaves the base of the cone in the form of a thin-walled—$^1/_4$ to $^3/_8$ in-thick—hollow cylinder.

A spray jet inside the hollow cylinder of falling material applies the solution. Internal scraper blades keep the sides of the Verticone clean at all times, preventing any build-up of materials. The treated materials drop onto a retention plate at the base of the Verticone where final and complete dispersion of the moisture takes place. A rotary table feeder discharges continuously to fit the flow of a materials-handling system, or to rapidly load trucks or rail cars. The discharged material can be removed by conveyer, chute, or other means as desired.

Such small amounts of moisture are added that they do not interfere with subsequent material-handling equipment or processing methods. The necessity of reducing materials to a slurry is completely eliminated. Where incoming material temperature exceeds 250 F, rapid wetting is achieved by the generation of steam, as plain water is applied through the spray jet. Under these circumstances, the use of the wetting agent is not recommended. However, the moisture content of the finished product is still precisely controlled by the Verticone application.

Pilotless B-47 Jets

THE use of pilotless B-47 jet bombers—termed QB-47 drones—is planned in remotely controlled missions hundreds of miles off the Florida coast at extremely low altitudes. The flights will be used for realistic testing of the nation's SAGE air-defense network.

A radar command-guidance-telemetry system developed by Sperry Rand Corporation, with the Air Force's Wright Air Development Division, Dayton, Ohio, will make the flights possible. The system can control many types of pilotless craft at both high and low altitudes, and it also employs a unique GC-130 aircraft as a sort of "flying command post" for the QB-47 missions.

The radar system, known as the Sperry Microwave Command Guidance, MCG, system, already has been used in remotely controlled flights of pilotless QF-80 jet fighters, Q-2 and Q-4 target missiles. In the case of the Q-4, it controls and monitors the missile at twice the speed of sound at altitudes up to 70,000 ft. In its new role, it will be used for controlling high-speed, 6-jet bombers at ranges exceeding 300 miles at both high and low altitudes.

The QB-47's will be "flown" by controllers on the ground at Anclote Point, near Eglin Air Force Base, Fla. Before the Eglin missions begin, however, the aircraft will be flown to Holloman Air Force Base, N. Mex., where a Sperry project will equip them for MCG operations.

In a typical mission, a highway van equipped with the Sperry MCG system serves as the Flight Control Central for the mission. It sends and receives coded radar impulses to a transponder in the QB-47. Controllers seated at a console in the van watch flight progress as it is displayed and recorded automatically on a large plotting board. They monitor radarscopes and a set of flight instruments similar to those in a manned aircraft. They command changes in course, speed, and altitude simply by pressing buttons and "beeping" a small control stick.

Whenever desired, an automatic course controller can be employed to guide the QB-47 automatically instead of using the manual controls.

In an "over-the-horizon" mission, the GC-130 airborne director station—equipped similarly to the ground station—is used to relay the radar commands and other flight data. Controllers aloft in the GC-130 also command the QB-47 directly when necessary.

Under positive ground or air control at all times, the QB-47 can fly a variety of missions in checking efficiency of the SAGE system. Missiles are fired at it, but provisions normally are made for scoring near-misses instead of direct hits, thus preserving each QB-47 for many flights.

Among the unique aspects of the Sperry system is the use of a single radar frequency band (X-band) for all command and telemetering functions. It thus does the job of a multiplicity of individual systems previously needed for the various portions of a complete drone mission.

5100-Ton-per-Hr Excavator

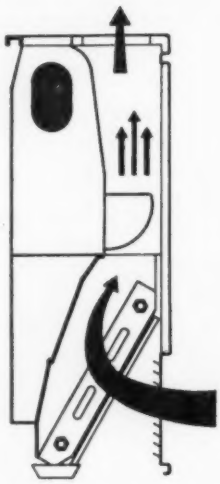
A GIANT new Bucyrus Erie 1054-WX wheel excavator weighs over 3 million lb and stands 176 ft high. Working in conjunction with a 70-yd shovel, it digs material on one side of a 100-ft open pit, then carries the dirt on 54-in. Raybestos-Manhattan conveyer belts, operating at over 1000 fpm, to a pile over 400 ft away.

Two conveyers are incorporated in the 1054-WX machine. One is a digging ladder, the other a stacking conveyer, mounted on the stacking ladder. Both belts are 54 in. wide. The 10-ply digging belt totals 203 ft; the 7-ply stacker belt is 732 ft long. Both were made by Raybestos-Manhattan and employ a type of belt construction which doubles their splice life.

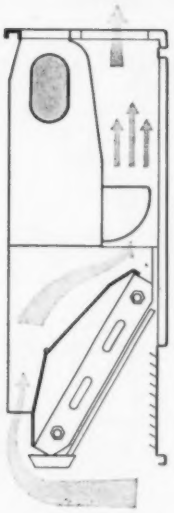
Belt speeds are high—so high they were believed impossible for this type of service a few years ago. Normal running speed for the digging ladder belt is 900 to 1000 fpm, and for the stacker conveyer belt 1000 to 1150 fpm. At these speeds the unusual flexibility built into the conveyer belts permits them to handle easily the 9-yd working capacity of the excavating wheel, which turns at 7 rpm in chewing up the 5100 tons of overburden per hr.

Right ▶
A 9-yd-bite, 63-yd-per-min wheel excavator carries dirt on a 54-in. conveyer belt at 1000 fpm to a pile over 400 ft away

◀ Left
Dust-free handling is provided by a bulk-material conditioner which adds a controlled amount of liquid to the finely divided materials



BYPASS DAMPER CLOSED



BYPASS DAMPER OPEN

A self-contained bypass arrangement will permit precise air conditioning of each room in the new United Engineering Center. Water temperature in the coil remains constant while the temperature of the output air varies with the proportion of the induced room air passing through. Any proportion of the room air can be bypassed to provide the proper room temperature.

UEC Air Conditioners

THE United Engineering Center, now nearing completion opposite the United Nations in New York City, will be the first large building to use the new By-pass Weathermaster Units made by the Carrier Corporation, Syracuse, N. Y.

These are individually controlled high-velocity induction units that will be wall hung beneath the windows. The self-contained bypass arrangement permits precise control of room temperature by the occupant. Instead of varying the water flow through the coil, as in past practice, bypass dampers regulate the amount of room air that flows through the coil.

In operation, conditioned primary air enters the base unit at high pressure. From there it flows quietly through plastic injector nozzles at high velocity. The resulting air stream induces room air over the unit coils where it is either heated or cooled depending upon the secondary water temperature in the coil. To maintain a constant discharge-air quantity, all of the room air passes over the coil when the bypass damper is fully closed or it completely bypasses the coil when the bypass damper is opened. Since any damper position between these extremes is possible, true automatic modulation is achieved.

The new built-in control device is claimed to reduce the installation costs of room equipment for high-velocity systems. Separate water-flow controls are unnecessary with the bypass system, and pneumatic piping is eliminated.

The individual wall-hung units are enclosed in prefabricated modular cabinets. Although it was not indicated whether they would be used at the UEC, mating bookcases are also available which conceal runouts.

Another interesting feature of the air-conditioning system for UEC, although not as new as the underwindow units, is a combination refrigeration system.

The UEC installation consists of a Carrier centrifugal chiller and Carrier absorption chiller, which results in an efficient 13.9 lb-per-ton-per-hr steam rate. If steam-turbine-driven centrifugals or steam-activated absorption units are used separately, they require between 16 and 20 lb per ton per hr.

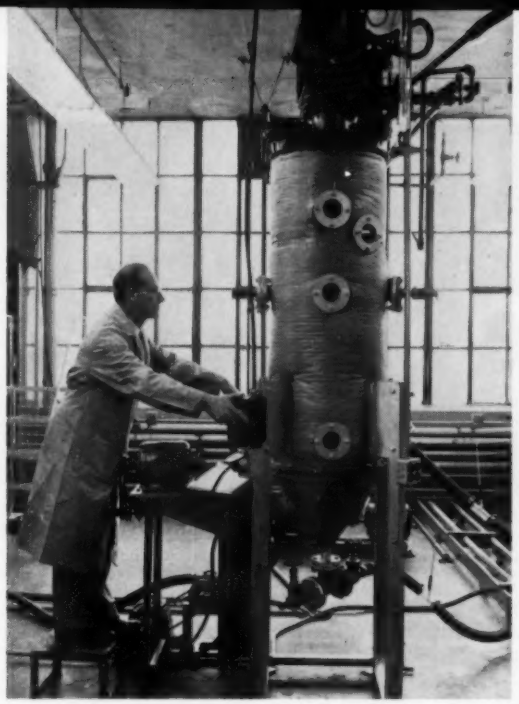
There will be 370 bypass units of four standard lengths from 24 to 52 in. used to air condition the approximately 2 million cu ft in the UEC. About one third of the air will be outside air and there will be approximately six changes of air per hour.

International Practical Temperature Scale

A REVISED text of the International Temperature Scale of 1948 was adopted at the October, 1960, meeting of the General Conference on Weights and Measures. It was prepared by the National Bureau of Standards, in cooperation with other members of the Advisory Committee on Thermometry.

No values of temperature on the scale have been changed, but the triple point of water (0.01 C) has replaced the ice point as one of the six defining fixed points of the scale. To avoid confusion between the International System of Units (1954), in which the unit of temperature is the degree Kelvin, and the International Temperature Scale, which is a practical scale, the name of the latter has been changed to the International Practical Temperature Scale of 1948.

Although it is recognized that the Kelvin thermodynamic scale is the fundamental scale to which all temperature measurements should be referrable, experimental problems make determinations on the Kelvin scale quite difficult. Therefore, in 1927, the 7th General Conference on Weights and Measures adopted an International Temperature Scale, ITS, defined by six fixed points and formulas establishing the relationship between temperature and the indications of instruments calibrated by means of the fixed points. These fixed points were the oxygen point (−182.97 C), the ice point (0.000 C), the steam point (100.000 C), the sulfur point (444.6 C), and the freezing points of silver (960.5 C) and gold (1063 C). The instruments used to determine this scale are: A



A small pilot crystallizer was used in perfecting a process for purifying aluminum sulfate—a key step toward producing alumina from clay and shales

standard resistance thermometer over the range of −182.97 to +630.5 C; a platinum-versus-platinum 10 per cent-rhodium thermocouple from 630.5 to 1063 C; and an optical pyrometer for temperatures above 1063 C.

In making the change the triple point, 0.01 C or 273.16 K, becomes the one point where the practical and thermodynamic scales exactly coincide.

New Feedwater-Heater Tube

Anaconda American Brass Company announces the availability of a new feedwater-heater tube known as 707 Anaconda heat-exchanger tube. The product was developed to afford manufacturers of power-plant feedwater heaters an alloy approaching the mechanical properties of more expensive metals presently available.

The company plans to market its new product in the annealed state, which will permit close U-bends.

The new alloy will have a maximum allowable stress value in tension of 15,200 psi at 600 F, exceeding the stress values attributable to considerably more expensive metals now on the market.

The 707 heat-exchanger tubes have a copper-nickel-iron-manganese composition, and a melting point of 1250 C. Typical tensile strengths are quoted at 84,700 psi for $^5/_8$-in-OD tube with an 0.049-in. wall, and 88,000 psi for a $^3/_4$-in-OD tube with an 0.049-in. wall.

Anaconda has made application for approval of its new alloy by the ASME Boiler and Pressure Vessel Code Committee. The new product can be welded satisfactorily into steel tube sheets of feedwater heaters with procedures the same as those used for the installation of other copper-nickel alloys.

The company says the new product has high resistance to stress-corrosion cracking and possesses excellent resistance to corrosion by sea water even at relatively high velocities. Tests are currently being conducted to determine the resistance of the new 707 alloy to exfoliation corrosion, such as occasionally occurs in feedwater heaters in generating units on peaking service.

Aluminum From Clay?

Olin Mathieson Chemical Corporation has announced an important breakthrough in industry's long search for a commercially practical way to make aluminum from common clay.

The corporation has, in the pilot-plant stage, an economical process for purifying aluminum sulfate. Material with an alumina content of as little as 20 per cent can be used.

"With this key step, it should be possible to produce aluminum where cheap power exists, without having to compromise on plant location to suit both the raw material and the power source," according to W. E. Hanford, Olin's vice-president for research. The shales associated with most coal could also be an excellent source of alumina. Dr. Hanford announced the process at the dedication of the new Olin Research Center in New Haven, Conn.

The aluminum sulfate produced by Olin's acid process can be processed into alumina, the basic raw material for the manufacture of aluminum. The present source of alumina is bauxite. Since the supply of this material within the United States is limited, much of it has been brought in by ore-carrying ships from the tropical "bauxite belt."

Olin, the nation's fourth-largest integrated aluminum producer, is a co-owner (with Revere Copper and Brass Inc.) of the Ormet Corporation's aluminum-reduction plant at Hannibal, Ohio, in the heart of the West Virginia-Ohio coal belt. Millions of tons of alumina-containing shales are available nearby as coal-mine waste, since most mines in that area must remove shale overburdens to obtain access to their coal.

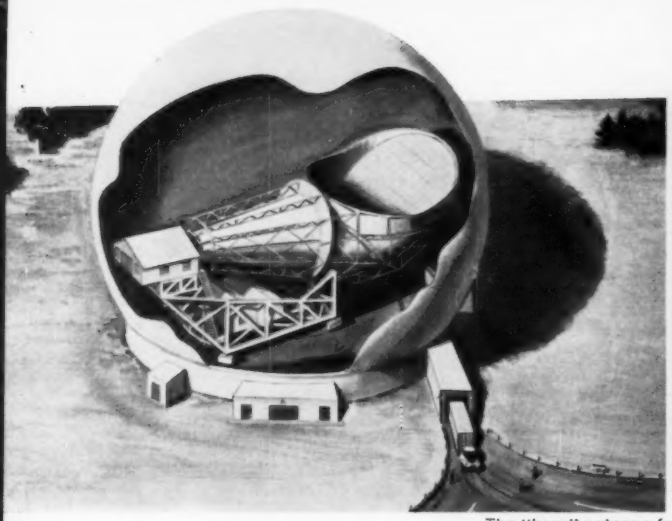
The Ormet plant, third largest in the United States, currently obtains bauxite from Surinam, South America, refines it to alumina at Burnside, La., and transports the alumina up the Mississippi and Ohio Rivers to Hannibal, Ohio.

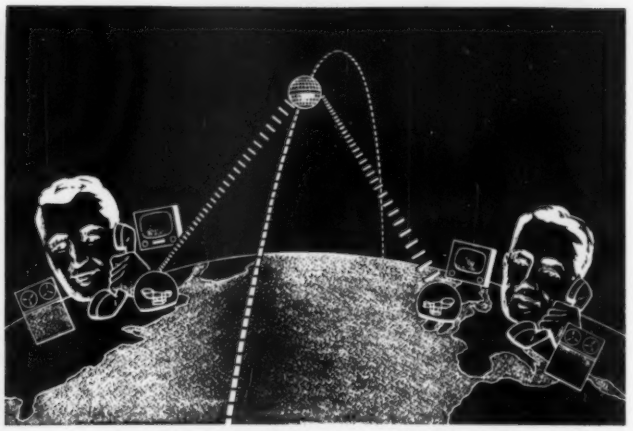
While many processes have been proposed for extracting aluminum sulfate from alumina-bearing clays and shales, Olin's new method is attractive economically because of the large size and purity of the crystals recovered in the crystallization step of these processes. Crystals are $^1/_8$ to $^1/_{16}$-in-diam, against less than $^1/_{100}$-in-diam for earlier processes.

Aluminum sulfate normally forms microscopic, soft, mushy crystals that are difficult and costly to separate from the impure solution. Crystals produced by the Olin process are coarse and sandlike—simple and inexpensive to handle. The difference in handling the two types of crystals is analogous to that of trying to wash dirt from mud, as compared with simply washing dirt from sand.

Plans are now under way to pilot the next step in this complex chemical problem.

This step—on which preliminary laboratory work has been very encouraging—consists of finding a thermal method for decomposing the aluminum sulfate to alumina and for economically recovering the sulfur trioxide. The latter would be recycled to the initial leaching step to extract more aluminum sulfate. The problem of winning alumina economically from clay has been under investigation for half a century. It has been estimated that during the past 25 years the Government and industry have spent more than $25 million trying to solve the problem. Olin now feels it has found the key to making this a commercially attractive process.





The "horn" antenna for overseas communication at Rumford, Maine, will be enclosed in an inflated synthetic-rubber and fabric "radome" 210 ft across and 161 ft high. People and even trucks will enter through air locks. The dome is "transparent" to radio waves. Telephone calls, television, and high-speed data will be beamed from the ground station to an orbiting satellite which will amplify the signals and relay them down to the ground station on the opposite side of the Atlantic.

Communications Satellites

EXPERIMENTAL transatlantic space communications will be conducted from a new ground station which American Telephone & Telegraph Company is constructing near Rumford, Maine, at a cost of $7 million. Basic research on space communications will continue at Holmdel, N. J.

The new station will do two things: (*a*) Beam signals to a satellite, which will relay them to Europe, and (*b*) serve as an antenna to receive faint signals that are relayed back from Europe by way of the satellite.

According to AT&T President Frederick R. Kappel: "It seems plain that satellite communication systems offer a practical means for relaying not only telephone conversations but also television and data across the oceans. We know how to build ground stations and satellites that will work together and in harmony with the communication networks of the various countries. We know also that satellite communication systems are urgently needed to supplement ocean telephone cables and other existing facilities, for the demand for international communications is growing very fast and the needs of the next few years must be met and met on time. Further, we are confident that the AT&T Company can produce a serviceable, economical space communication system, capable of giving high-quality service to the public—and do it quickly. We are already well along on developing an experimental satellite. What we need now is for some branch of government to launch this so we can start testing. And we would be glad to pay for the rockets."

Commercial transatlantic telephone service dates from 1927 when 11,000 overseas calls were made. The number of calls had grown to 2.5 million in 1957, and nearly 4 million in 1960—increasing at the rate of about 20 per cent per year.

The horn that will be used in the Rumford installation is a highly sensitive antenna designed and developed by the Bell Telephone Laboratories. It will be ready by early next year and is a 250-ton steel and aluminum structure—a rotating antenna 177 ft long, 94 ft high. It will be protected from wind and weather by the largest inflated earthbound structure yet made.

Its spherical cover, or "radome," supported by air pressure, will be 210 ft wide, 161 ft high—about as high as a 13-story building. It will enclose about twice the space of the seating area of Radio City Music Hall. The radome is designed to weather the strongest anticipated gales. Its skin will be 20 tons of synthetic rubber and fabric $^1/_{16}$ in. thick which would cover three acres if laid out flat.

Rumford's antenna will be an enlarged version of the horn antenna at Holmdel, N. J., which was used successfully for Project Echo. However, the Rumford antenna will provide nine times as much antenna surface.

The Bell System expects to start construction of the ground-station complex by May 1.

The Rumford area was selected because it is far from routes of microwave-radio relay stations that operate on the same frequency bands. Signals from satellites are very weak, hence they are especially vulnerable to interference from signals in the same frequencies—even those considered weak by ordinary standards.

Topographically, the site is a broad, 900-ft-high saucer-shaped hill ringed by mountains up to 3800 ft high that help block off stray radio interference from other areas. The mountains are not so high that they will block communications with satellites.

Although specific sites for ground stations in other countries have not been announced, the British plan to have one in the British Isles, and the French and West German communications administrations plan to take part.

Niagara Project Dedicated

THE first power was generated by the Niagara Project of the Power Authority of the State of New York on February 10. The occasion, just 1107 days after the Federal Power Commission gave the Power Authority a workable license, was marked by a dedication ceremony. The ceremony was the culmination of three years of feverish activity since the first large construction contract was awarded within four days of the receipt of the license. The collapse of the Schoellkopf power plant and a power shortage had induced Congress to grant New York State the right to preserve and develop Niagara River, Falls, and Gorge rather than five private utilities.

The enormous enterprise, costing $720 million for power alone, and $1 billion including related improvements, will have a completed capacity of $2^1/_4$ million kw—a total greater than that of Grand Coulee Dam.

The Robert Moses Niagara Power Plant will have an

average gross head of 314 ft, will be 1530 ft long and 389 ft high. Each of the 13 generating units will have a capacity of 150,000 kw.

A reservoir pump-generating plant (see MECHANICAL ENGINEERING, March, 1960, pp. 74–77) will use off-peak power for 12 reversible pump-generators. These will provide additional daylight power when the amount of water allowed to flow over the falls (because of their scenic value) decreases the amount available for generation.

The head range for pumping will be 62 to 107 ft; for power generation, 60 to 100 ft. Each of the 12 units will have a capacity of 20,000 kw.

The total annual energy output for the project is expected to be 13 billion kwhr.

Cheaper Sandwich Panels

A CHEAPER method of producing corrugated-core sandwich panels has been developed in research sponsored by the Douglas Aircraft Company at Battelle Memorial Institute, Columbus, Ohio. The method requires no jigging, provides completely sound core-to-cover bonds, and allows the panels to be extensively formed after assembly.

Called roll-welding the process uses hot rolling to pressureweld the peaks of the corrugated metal core to the cover sheets.

Size of the sandwich panels is limited only by rolling-mill capacity. Panels as large as 36 × 72 in. and $^1/_4$ in. thick have already been produced. Roll-welded sandwich panels have been made of 2014 aluminum alloy, B-120 VCA titanium, unalloyed A-55 titanium, steel, molybdenum, and Inconel.

To form the corrugated core, an accordion-pleated sheet of metal is woven over and under the V-shaped inserts of a chemically soluble, deformation-resistant metal such as copper or iron. A rectangular metal frame is placed around the core, and the face sheets of the sandwich are added. The entire assembly is clamped in place by two additional metal cover sheets, which are welded to the rectangular frame. The whole package is then hot rolled in a direction parallel to that of the corrugations.

In addition to welding the core to both covers, rolling also reduces the thickness of the panel up to 60 per cent to provide desired corrugation shapes.

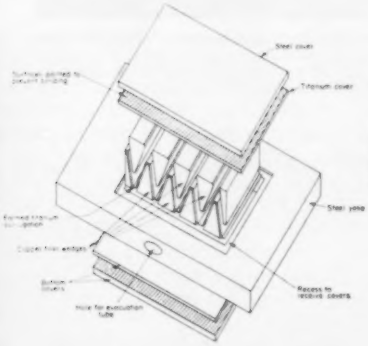
After rolling, the retaining frame is sawed or sheared off and the metal covers which were welded to the frame are peeled away. With the support wedges still in place, the sandwich panel can now be formed into a wide variety of shapes, including hemispheres, without buckling the core. Standard tooling can be used, and the panel can be worked as though it were a solid metal plate of equal thickness.

The V-shaped inserts are then leached out of the formed structure with a chemical reagent, such as nitric acid. Although the leaching process requires several days for very large panels, it is a straightforward operation and is relatively inexpensive. If necessary, leaching can be accelerated by mechanical means.

Roll-welding can also be used to produce sandwiches with vertically ribbed cores, since core design is determined by the design of the filler wedges. The only limitation is that the core has to be unidirectional.

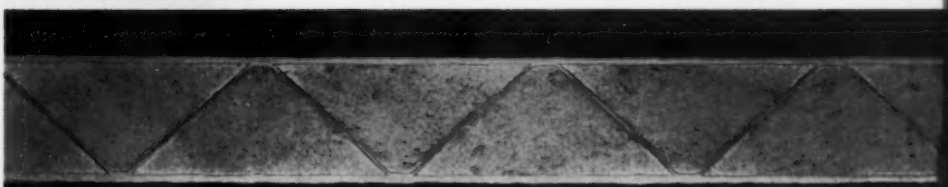
Roll-welded corrugated sandwich panels approach the all-round rigidity of honeycomb sandwiches and are simpler and much less costly to manufacture.

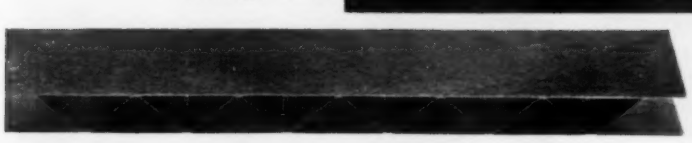
Corrugated-core sandwich panels are prepared by inserting solid metal filler wedges of a chemically soluble metal. No jigging is required but hot rolling pressure welds the peaks of the core to the cover sheets.



An exploded view of the pack assembly used for producing the roll-bonded corrugated-core-type sandwich panels

Sound core-to-cover welds are evident in this cross section of a titanium sandwich before the wedges have been dissolved. At this stage, the panel can be formed by standard tooling into a wide variety of shapes, including hemispheres, without buckling the core.



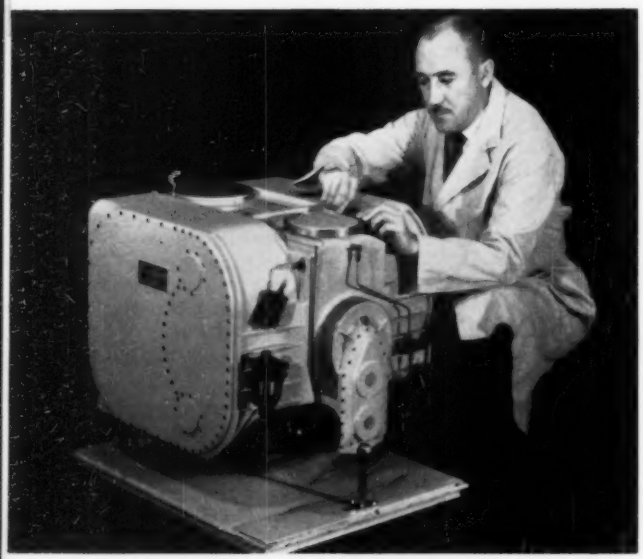


The finished panel is produced by leaching out the wedge inserts with acid. Corrugated-core sandwich panels approach the all-around rigidity of honeycomb sandwiches but are simpler and cheaper to make.

600-Hp Gas Turbine

A 600-HP gas turbine, which is expected to surpass piston engines in competitive applications, is being developed by Solar Aircraft Company, San Diego, Calif.

The Company has received a multimillion-dollar contract from the U. S. Navy Bureau of Ships for a joint Army-Navy development of a turbine which has design objectives far beyond the current state of the art. These include: (*a*) A life cycle equal to or better than that of conventional reciprocating engines—with considerably less maintenance; (*b*) fuel consumption of 0.4 lb per hp-hr, equal to reciprocating engines and well below current industrial gas-turbine performance; (*c*) a cost competitive with conventional reciprocating engines.



Expected to be competitive with piston engines in cost and performance is a 600-hp gas-turbine engine under joint Army-Navy development by Solar Aircraft Company and aimed at filling an across-the-board need for the military and industry

Among potential uses are vehicle and marine propulsion; generator, pump, and compressor drives; and as an air-conditioning power source. It is aimed at filling an across-the-board need for the military and industry.

According to Solar engineers, the new 600-hp engine is a completely axial-flow regenerative machine with a six-stage compressor, dual rotary regenerators, a single-can combustor, a single-stage gas-producer turbine, and a single-stage power turbine.

The engine will operate at a compressor pressure ratio of 3.8 and have a rotative speed of 21,500 rpm.

Economic Thickness of Insulation

A PRACTICAL means for specifying the exact thickness of thermal insulation needed for maximum economy has been achieved by engineers at the Union Carbide Chemicals Company, South Charleston, W. Va., in co-operation with the College of Engineering, West Virginia University. The system is applicable to any type of heat-using industry anywhere in the world.

The study showed that realizable savings of up to $2 per ft of line per yr should be possible with the proper thickness of installed insulation. This would mean savings of millions of dollars a year for large firms.

Charts, rather than complex mathematical formulas, enable an engineer to find quickly the solution for any of billions of possible combinations of variables. These include the cost of heat energy, cost of insulation, cost of capital at various periods of amortization, and conductivities of insulations at different temperatures.

Although the basic equations for the calculation of economic thickness of insulation were worked out as far back as 1926 in a now-classic ASME paper presented by L. B. McMillan (*Trans. ASME*, vol. 48, 1926, pp. 1269–1318; condensed in MECHANICAL ENGINEERING, vol. 49, 1927, pp. 898–907), the authors of the present study state that they were too difficult to apply in any but the simplest set of conditions.

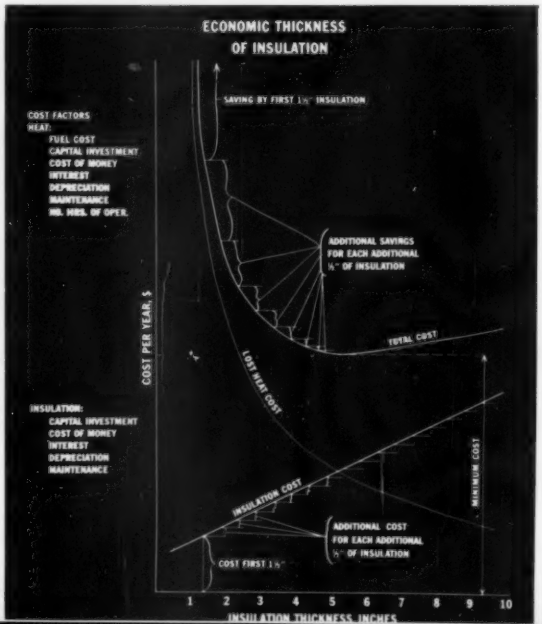
What the Carbide task force accomplished was to combine into a single *D* factor the variables involved in heat cost and insulation cost, and then make the new formula workable by means of a series of four sets of charts. In practice, any realistic combination of conditions, including possible increases or decreases of costs at least 23 years into the future, are included in the tables. Twenty-two pipe sizes, $\frac{1}{2}$ to 36 in., and flat surfaces, temperature differences ranging from 90 to 1314 F, and insulation conductivities from 0.10 to 1.5 are covered in the tabulations.

Using an IBM 650 computer, the team of engineers and mathematicians reduced this information to 141 tightly packed pages of graphs and tables. The 83 hours of electronic computer time would have required 500 man years if the work had been done on the fastest available electric calculator. The rest of the 182-page manual has introductory material and sample problems.

Proceeding from the elementary principle, "the greater the thickness of insulation the lower the heat loss," the study demonstrates the importance of fixing the point at which a last half inch of added insulation will provide a return on investment—often as high as 30 per cent a year.

The National Insulation Manufacturer's Association, New York, N. Y., will publish the formulas and tables in a revised edition of the "Manual on Economic Thickness of Insulation for Flat Surfaces and Pipes" for general distribution to industry. It will be available from NIMA, 441 Lexington Avenue, New York 17, N. Y. after June 15, at $10 per copy.

In determining the most economic thickness of insulation, the cost factors for heat saved have to be weighed against the added cost for each additional $\frac{1}{2}$ in. of insulation. A practical method using charts and tables is announced.



Materials Briefs

▶ Zinc-Coated Steel Has Better Paintability, Weldability

A spangle-free, hot-dipped, zinc-coated steel has been developed by Armco Steel Corporation, Middletown, Ohio, specifically to improve paintability characteristics of current paintable galvanized steels.

The spot-welding properties and corrosion resistance of the new material also are superior to those of paintable standard zinc-coated steels, according to Armco.

Designated Zincgrip A, Paintgrip, the material is chemically treated for maximum paintability. The sheet is produced in both 1.25-oz-class zinc coating as specified by ASTM A-93, and in light commercial coating weight.

Producing a spangle-free, immediately paintable galvanized sheet carrying a 1.25-oz-class zinc coating for corrosion resistance has been an industry goal.

▶ Railway Cars for Helium

To keep pace with mounting orders, the U. S. Bureau of Mines has awarded a $2.3 million contract to the low bidder, American Car and Foundry Division of ACF Industries, Inc., New York, N. Y., for 23 custom-built helium tank cars.

Helium shipments in fiscal 1960 totaled 420 million cu ft and are expected to reach 530 million cu ft in 1961. Delivery of the 23 new cars will bring the Bureau's tank-car pool, which handles 80 per cent of all helium deliveries, to 211. Of these, 25 are owned by the Atomic Energy Commission.

Helium tank cars are the only railway cars of their kind. Each consists of 30 individual seamless, forged-steel tubes. During World War II, these had an average capacity of 200,000 cu ft of helium at a pressure of 2000 psi. Today, with improved manufacturing and product-control techniques, the new cars can hold 300,000 cu ft at pressures up to 3800 psi.

▶ Cold-Work Tool Steel With Improved Wear Resistance

Four times the service life of high-carbon, high-chrome steels is claimed for Hi Wear 64, a new tungsten tool-and-die steel developed by the Carpenter Steel Company, Reading, Pa. It is a deep-hardening grade which can be easily and economically heat-treated at much lower temperatures than those required for other steels designed for high-wear applications. The type analysis is C, 1.50; Mn, 2.00; Si, 0.25; Cr, 0.90; Mo, 1.00; W, 4.00.

Hi Wear 64 hardens through to the center in sizes up to 6-in. cross section when oil-quenched from 1450 F. Intricate shapes up to 2 in. in diam can be air-hardened from 1550 F. In comparison, air-hardening, high-carbon, high-chrome steels require heat-treatment at 1800 F or higher.

The relatively low hardening temperature of this steel offers maximum protection against the danger of decarburization, distortion, and surface damage. It saves also the expense of high-temperature treating.

This grade is essentially a nondeforming tool-and-die steel, with minimum size change occurring after tempering at 300 to 400 F. A 1-in. piece, for example, when air treated from 1600 F will expand about 0.001 in. when hardened. But it will return to within 0.0005 in. from its original length when tempered at 300 to 400 F.

Hi Wear 64, which had been patented, can be used for any applications requiring maximum wear resistance. It is recommended for all kinds of punches and dies including draw dies, lamination dies, and blanking dies. It is an excellent material for tools to blank and form abrasive materials, phosphor bronzes, and nickel strip and is also ideal for mold plates used in making refractory materials, and for feed rolls handling abrasive materials.

Nuclear Briefs

▶ Beryllium-Oxide Reactor Experiment

To provide data on the use of gas-cooled reactors for maritime and other civilian power applications, the Atomic Energy Commission will build a reactor experiment at the National Reactor Testing Station in Idaho, designated the Beryllium Oxide Reactor Experiment, BORE.

A program for the design, construction, and test operation of the facility has been assigned by the AEC to the General Atomic Division of the General Dynamics Corporation, San Diego, Calif. The work will be part of the AEC program to develop a closed-cycle, gas-turbine marine-propulsion plant powered by a high-temperature, helium-cooled, beryllium-oxide-moderated reactor.

The reactor will be fueled with a mixture of uranium oxide and beryllium oxide. Such a propulsion system offers potential advantages in economy, weight, compactness, and inherent safety. Conceptual design for the reactor experiment was prepared by the General Atomic Division.

Construction is scheduled to start this summer. Completion of the facility will depend on the program of research and development work currently underway.

The BORE core is presently planned to be about 75 in. long by 24 in. in diam, surrounded by a 7-in-thick beryllium-oxide reflector. The facility will be designed to permit nuclear operating conditions similar to those of the marine propulsion plant under development, including helium outlet temperatures up to 1500 F and pressures as high as 1120 psia and power levels up to 10,000 tkw.

▶ Closed-Cycle Gas-Cooled Nuclear Power System

The Mobile Low Power Reactor No. 1, ML-1, achieved criticality recently at the National Reactor Testing Station, near Arco, Idaho. The first direct and closed-cycle gas-cooled nuclear power system anywhere, it uses the gas heated in the reactor core to drive a gas turbine and generator to produce 300 to 500 ekw.

The reactor was designed and built and is being operated for the Atomic Energy Commission by the Aerojet-General Corporation, Azusa, Calif. The power-conversion unit is being built by the same company and is scheduled to arrive at the Idaho testing station this fall.

The entire plant is skid-mounted in six packages totaling less than 38 tons and can be transported by standard Air Force cargo aircraft, standard Army low-bed truck-trailer, train, or barge.

The reactor, which is water-moderated, nitrogen-cooled, and capable of generating approximately 3400 tkw, can be placed in full-power operation 12 hr after arrival and readied for movement to a new location 24 hr after shutdown. Other characteristics are reliability for continuous operation in extreme climatic conditions and ruggedness in shipping and handling.

PHOTO BRIEFS

M. BARRANGON

Contour Cable. To replace bulkier round wiring in missiles, Hughes Aircraft developed flat metal strips embedded in plastic dielectric ribbon. Flat and flexible, and carrying up to 40 conductors, it cuts size and weight of conductors, dissipates heat.

Hypodermic Lubrication.

From the "clean room" of the Fafnir Bearing Company, New Britain, Conn., come miniature bearings lubricated with a hypodermic needle capable of controlling the input within one milligram. The bearing is weighed on a fine balance before and after lubrication.

Fiber Spinning. Can that new polymer be spun into fiber? This closeup of a spinning head shows multi-filaments of Nylon 6 being extruded during an experimental run at Fabric Research Laboratories, Dedham, Mass.

High-Speed Tire. A new cord angle in this 4-ply nylon tubeless tire by Goodrich eliminated the shock waves which can rip a tire to pieces. It showed no signs of weakness after 90 miles at 115 mph, and 4000 at 85 mph.

Prototype Printed Circuit. Corning Glass puts Fotoceram grid boards in kits to enable a designer to make prototype printed circuitry in 15 minutes without leaving his desk. Etching resist comes in ball-point tube pens.

Gas-Turbine-Powered Fire Truck. Boeing believes this ladder truck (now in use in Seattle) to be the first such vehicle propelled by a gas turbine — as well as the fastest starting, fastest accelerating. It has a 335-lb, 330-shp Boeing turbine.

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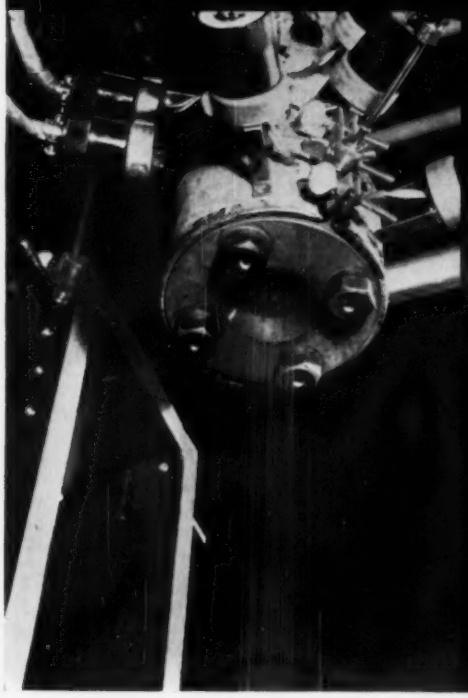

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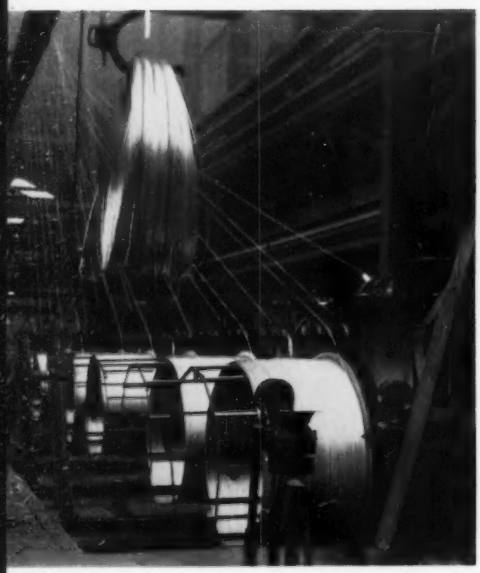
Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY



High-tensile steel wire for suspension cables of the Forth Road bridge, Scotland, is guided onto take-up frame on galvanizing line, **far left.** Finished coil hangs on hook ready for transport to storage in polyethylene bags, **left.** Bags are equipped with dehumidifiers to prevent rust. The stored coils vary in weight from 850 to 1050 lb. The manufacturer is supplying 7500 tons of the wire.

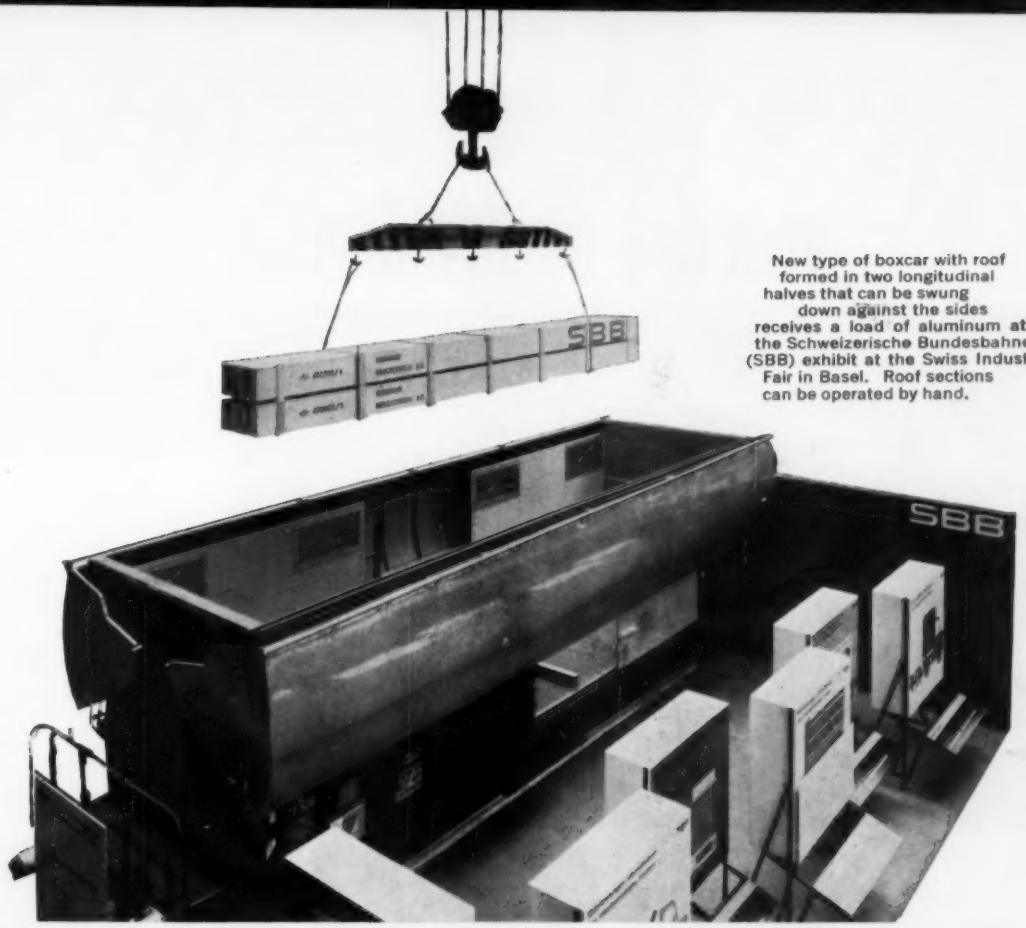
Bridge Suspension Cables

DORMAN LONG (STEEL) LTD., of Middlesbrough, England, has almost completed its contract for the supply of 7500 tons of high-tensile steel wire for the suspension cables of the new Forth Road bridge in Scotland, which will have a main span of 3500 ft. It is the first bridge in the United Kingdom to be built with parallel-wire suspension cables. The wire specification called for a diameter after galvanizing of 0.196 in., with tolerances of plus 0.003 in. and minus 0.002 in.; a tensile strength of 100 to 115 tons psi and an average of not less than 102 tons; a 0.2 per cent proof stress of 75 tons psi minimum; and an elongation of 4 per cent minimum on a gage length of 10 in. The wrapping test is on three times the wire diameter, and it was further required that a 100-ft length must be perfectly straight under a tension not exceeding 300 lb. The wire is hot-dip galvanized.

Each of the two suspension cables will contain 11,618 wires and will be $23^1/_4$ in. diam. inside the wrapping wire, which has a diam of 0.148 in. after galvanizing. At the anchorages the wires will be divided into 37 strands, each of 314 wires, which will be splayed out and looped around steel "strand shoes," forming the attachments to the anchorages. In all, there will be about 30,000 miles of wire in the bridge. As it is finished, the wire is wound into coils varying in weight from 850 to 1050 lb and sent to a store where the coils are stacked under polyethylene sheets in which they are completely sealed. Inside each polyethylene "tent" is a dehumidifying unit that dries the entrapped air and prevents what is known as white rusting. When the spinning of the cables begins in a few weeks, the wire will be sent by rail to the site of the bridge at a rate of about 800 tons per week.

Swiss Industries Fair

LIKE most of the European trade fairs, the Swiss Industries Fair at Basel is an annual event, but because (unlike the German Industries Fair at Hanover) the site is in a built-up area, the emphasis on particular industries varies from year to year. This year, for example, there were no displays of machine tools or of textile machinery, but plastics figured more prominently than before, and Hall 7 was given over entirely to a mechanical-handling plant and associated exhibits. The heavy machinery section was moved from Hall 6 to the better-lighted Hall 5, where the Sulzer monotube boiler was the bulkiest exhibit. However, physical limitations obliged this firm to show only by photographs and diagrams one of its most important current contracts, the four vertical two-stage double-flow pumps being constructed for the Blaenau Ffestiniog pumped-storage hydroelectric station in North Wales. These pumps, with impellers 8 ft 6 in. diam, running at 428 rpm, will deliver 745 cu ft of water per sec against a head of 1000 ft, and weigh 292 tons each. At their maximum discharge rate they will require 110,000 hp each.



New type of boxcar with roof formed in two longitudinal halves that can be swung down against the sides receives a load of aluminum at the Schweizerische Bundesbahnen (SBB) exhibit at the Swiss Industries Fair in Basel. Roof sections can be operated by hand.

Swinging Roof Boxcar

THE Swiss Federal Railways (more commonly known as the SBB for Schweizerische Bundesbahnen) have been devoting much attention recently to the loading and unloading of cars. In the mechanical-handling section of the Swiss Industries Fair they showed a new type of boxcar with a roof formed in longitudinal halves. These can be swung down against the sides, leaving clear access to the full interior dimensions of the body. The opening allows long or awkward loads, such as crated consignments of tubes, to be loaded or removed by crane. The roof sections are of aluminum alloy and are balanced by means of dashpot cylinders so that they can be operated by hand. The usual side loading doors, 2 m square, also are provided. The underframe, brake gear, and so forth, are of the railways' standard type. The interior length of the car is 9.26 m (32 ft) and the width is 2.72 m (8 ft 11 in). The builders are Schindler Wagons S.A., of Prattelin, Switzerland.

English Channel Tunnel

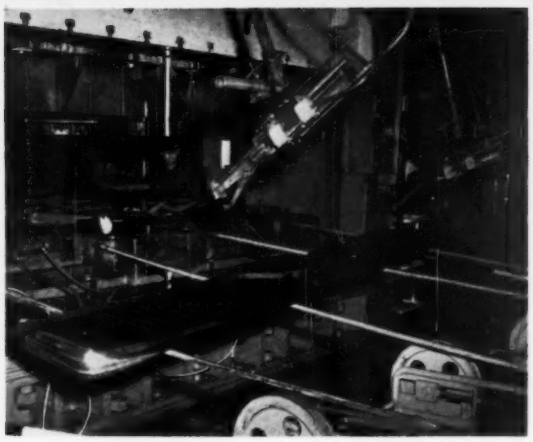
INTEREST periodically revives in the practicability of constructing a tunnel under the English Channel. It was first proposed nearly 160 years ago, revived in the 1830's, reached the stage of trial borings in 1865 and of pilot headings a mile long on both sides of the channel in 1882–1883. At this point the British government stepped in and for strategic reasons put a stop to the project. In 1929, however, a British parliamentary committee reconsidered the matter and reported in favor of a tunnel. The British House of Commons turned down the proposal by a majority of only seven votes, but those interested did not abandon the idea and in 1957 set up a study group consisting of representatives of the (British) Channel Tunnel Company, the corresponding company in France, the Suez Canal Company (which was financially interested in the scheme), the International Road Federation (Paris), and Technical Studies, Inc., of New York. A report on their work and findings between 1958 and 1960 was recently presented in London at a joint meeting of the Institution of Civil Engineers and the British Section of the Société des Ingénieurs Civils de France.

From surveys made in 1958 and 1959, which included a re-examination of earlier investigations, it was concluded that the scheme was geologically feasible. From the engineering and economic points of view, there was a choice of several methods: A bored tunnel or tunnels, an immersed tube of prefabricated units laid in a dredged channel (this inquiry was entrusted to the New York consulting firm of Parsons, Brinckerhoff, Quade and Douglas); or a bridge over the whole width of the channel (about 21 miles); or a bridge from France to the Varne Bank and thence a tunnel to England. This last could only have been a road tunnel because of the gradients. The group found that the cheapest form of construction would be twin railway tunnels using electric traction at 25,000 volts. With a train every 5 minutes, which was considered practicable, the tunnels would carry 1800 road vehicles per hr in each direction. The estimated time required to build the tunnels was five years, of which four would be spent in actual excavation and lining. Estimated cost of the rail tunnel was $290 million.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Visit to a Small-Car Plant

1 Press Shop. Editors from American magazines inspect massive presses that mold the compact Volkswagen in press shop at plant in Wolfsburg, Germany. About 40 per cent or 48 of the presses are American-made by Clearing and Danly. The heaviest press operates at 1600 tons pressure.



2 Stamping. Ingenious mechanical hand moves stamped steel floor pan onto conveyer for transfer to next operation. About 140 tons of steel plate are consumed daily. In 1960 Volkswagen purchased some 40,000 tons from U. S. Steel and Bethlehem Steel.

In November, 1958, the Sperry Award Committee presented The Elmer A. Sperry Award to the late Prof. Ferdinand Porsche for designing the Volkswagen; to Prof. Heinz Nordhoff for efficient production and universal distribution of Volkswagen automobiles; and to the men and women of the Volkswagenwerk GmbH for their essential contributions to the development, production, and world-wide use of Volkswagen automobiles.

The Sperry Award, which is sponsored jointly by The American Society of Mechanical Engineers, Society of Automotive Engineers, American Institute of Electrical Engineers, and The Society of Naval Architects and Marine Engineers, had never before been bestowed on engineers of the automobile industry—or on a non-American.

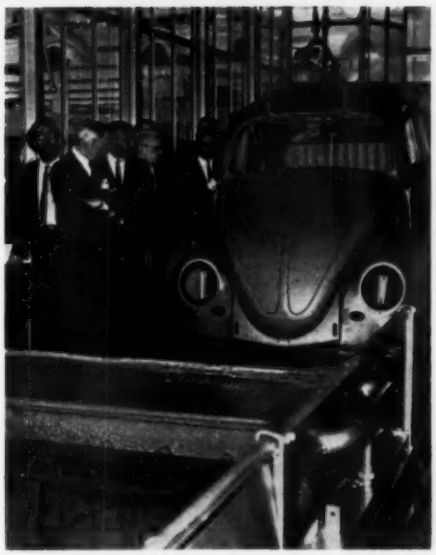
Recently, a group of U. S. editors was given the opportunity to see firsthand the Volkswagen plants in Germany and some of the men and women who created the little beetle-shaped car.

Headquarters for Volkswagen in Germany is the town of Wolfsburg, located in the northern part of Germany. In 1937 it was a hamlet of 150 people. Today Wolfsburg is a sparkling new town with a population of more than 60,000. The Volkswagen factory there employs 37,000 people. Half of them live in Wolfsburg, the other half are commuters from surrounding towns. There is no other industry in Wolfsburg. In Hannover, 50 miles away, the VW truck plant employs 18,000 people; in Kassel, the spare-parts plant, 6000 are employed; in Braunschweig another 4000 produce front suspension assemblies.

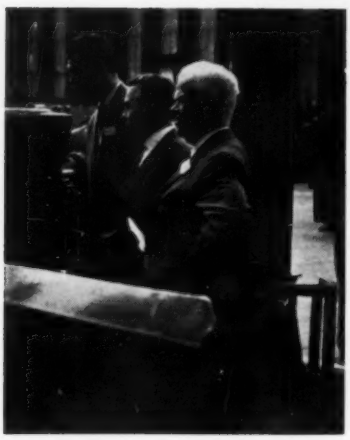
Interestingly, a 165,000-kw private power station produces electricity and heating for both the factory and the town of Wolfsburg (remote central heating). Daily consumption is 2,000,000 kwhr. And the power station uses 1000 tons of coal per day—one third of which is imported from the U. S.

Wolfsburg got its name from a Renaissance castle

4 On the Roundabout. Individual parts for the rear of the car are automatically welded at 318 points in this revolving assembly rig. Included are five welding, one lifting, and three fitting-out operations.



3 Looking it over. VW guide, **center,** explains operation of a McKay leveling machine. At **left,** ASME Editor J. J. Jaklitsch, Jr., and at **right,** Carl C. Harrington, Mem. ASME, Editor of Mill and Factory.



5 Painting. In the paint shop, a VW is being hoisted over a body dip tank. All VW's are bonderized, dipped, electrostatically sprayed (Ransburg process), and hand-spray coated. **6 Final Assembly.** Three of the six final assembly lines are shown in action here. Every minute three finished VW's leave the conveyers. Prior to shipment, all cars undergo a series of stand tests.

which now belongs to the State of Lower Saxony. It is used as a refugee center, sheltering families who flee from East Germany. (The East German border is about eight miles from Wolfsburg.)

In 1938, work began on the Volkswagen factory. In that same year work also started on the first buildings of the town.

Production of military vehicles began in 1940 and by 1945 55,000 military VW's and 15,000 amphibious VW's were built there, as well as some ammunition and spare parts for bombers. By the end of World War II heavy bombings had destroyed over 60 per cent of the plant.

After World War II, Allied Occupation Forces tried to interest American, French, Russian, and British industry in the VW plant. Experts tested the car, but decided it would never sell in quantity and they did not want to be bothered with it. As a result, the plant was turned over to the Germans.

In 1948, Professor Nordhoff was appointed general manager of the plant. Equipped with strength and will plus the knowledge he had acquired at his previous work with General Motors, he said: "My life's aim is to make this plant into the greatest car factory in Europe."

This he accomplished. For not only is Volkswagen the largest motor-car producer in Europe, it is now the fourth largest in the world—coming right after America's "big three."

Yearly production rose from 19,244 VW's in 1948 to 553,399 in 1958 and to over 865,000 in 1960, or nearly 4000 cars and commercial vehicles a day. All cars are made in Wolfsburg. The commercial vehicles and station wagons are made in Hannover, as well as all engines and transmissions.

Employees increased from 8361 in 1948 to more than 65,000 in 1960.

Ten years after the war, August, 1955, the millionth VW rolled off the assembly lines. This year, Volkswagen will produce 1,000,000 vehicles.—*J.J.J., Jr.*

Substance in Brief of Papers Presented at ASME Meetings

ASME TECHNICAL DIGEST

Railroad

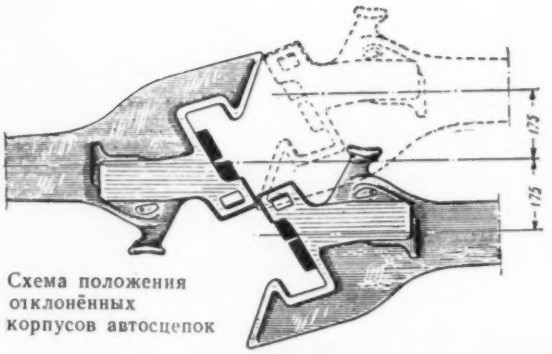
Mechanical Engineering Progress on Russian Railroads..60—WA-283... By William M. Keller, Fellow ASME, Association of American Railroads, Chicago, Ill. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An exchange delegation to Russia, of which the author was a member, studied progress in Soviet railroads. The visiting delegation traveled 6500 miles by train through the country. Such cities as Moscow, Kiev, Kharkov, Baku, Sochy, Stalingrad, and Leningrad were visited, and the delegation inspected the railroad facilities at these points and observed conditions enroute between cities. The author's comments are based on this inspection and meetings with the Soviet railroad officials.

It is noted that the progress in the field of mechanical engineering is substantial. The rail equipment, while not up to United States standards is improving, notably through the use of four and six-wheel trucks, automatic couplers, automatic air brakes, and larger-capacity cars. Adoption of electrification and dieselization is also a progressive step. The author paid particular attention to the education and research programs in effect. In this area the work is extensive. Much of the training is in the technical area of improving craftmanship in the railroad arts. Extensive education of the formal type was also observed, but there was no evidence of superiority over the same kind of education in the United States.

Strength Requirements for Special Cars to Transport 40-Ft Trailers..60—WA-263 ...By H. L. Decker, Mem. ASME, The Pennsylvania Railroad Company, Philadelphia, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The need for a lightweight flat car capable of carrying two refrigerated highway trailers 40 ft in length is pointed up by a review of the background development of that portion of railway service which deals with the carrying of highway trailers on flat cars. The design parameters for such a car are discussed. Basic dimensions of 85-ft length, 8-ft 6-in. width, and 62-ft truck centers are established, and the expected static and dynamic forces (including those engendered by the use of the trailer hitch) on the car structure are analyzed. Three design solutions fulfilling the necessary basic dimensions and strength requirements are described along with subsequent changes that service experience and later testing indicated.



Cross-section diagram of Soviet automatic coupler with transition lugs cast on coupler heads. The Russians use a lug to provide a means of coupling with a screw couple (60—WA-283)

Схема положения отклонённых корпусов автосцепок

Operational Experience With the Chesapeake and Ohio Railvan..60—WA-276... By George J. Sennhauser, Chesapeake and Ohio Railway Company, Cleveland, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In May, 1959, the Chesapeake and Ohio Railway Company began experimental Railvan operations. Although at the outset of service, a number of mechanical shortcomings arose, these have been substantially corrected. They are described. To date, Railvans have run over 500,000 miles with an availability record of over 90 per cent.

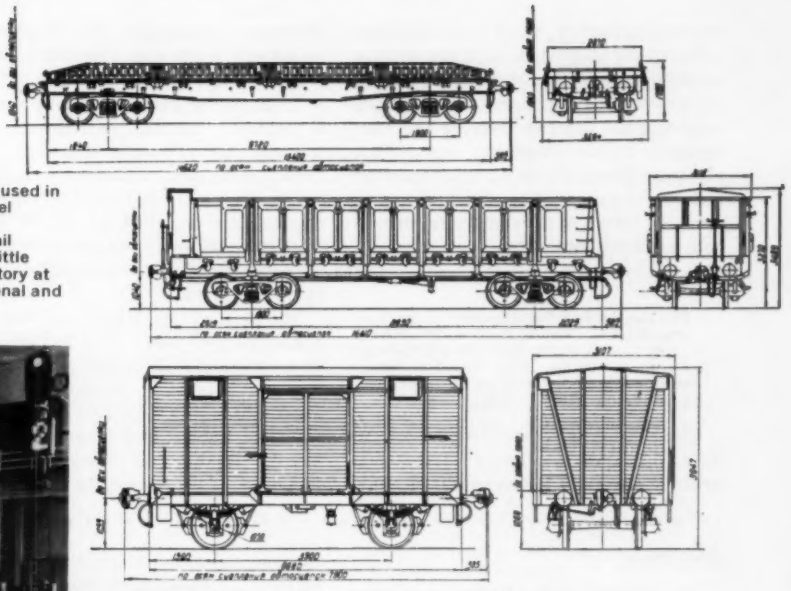
The transfer operation, in which a two-man crew uses the specially designed transfer vehicle, requires about 2 min to transfer a Railvan from the rail position in a train to the highway position on the parking apron. About 3 min are required for the reverse operation.

In general, the mechanical proving phase of Railvans is virtually completed. The equipment has been tested and developed to a point where it may be safely produced in production quantities. At the present time, the C and O is conducting a market survey to determine where additional Railvans can be most advantageously used.

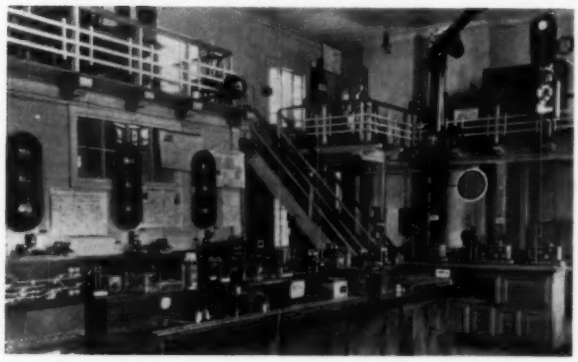
Effect of Design of Classification Yards in Reducing Lading Damage..60—WA-325... By Alfred V. Dasburg, General Railway Signal Company, Rochester, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The basic classification yard consists of a group of parallel tracks connected at each end by switching leads. An engine crew pushes and pulls a string of cars along one of the leads to sort the cars into individual tracks. The gradients of the tracks are generally almost level and impacts resulting from the sorting operation are dependent upon the skill of the engineman and the instructions he receives from his crew. Because of the necessity for frequent reversals of the locomotive, productivity is low and the average number of impacts per car may be high.

The need for increased productivity led to the development of the gravity type of classification yard, in which one track is run over a small rise or hump, permitting



Soviet four-axle freight car, **above right,** is one of the higher capacity cars now being used in USSR. **Center right** is a high-capacity steel hopper car. Two-axle box car, **lower right,** is said still to be in use in Soviet rail network, which is estimated to cover a little over 75,000 miles. Interior of signal laboratory at Moscow Institute, **below,** shows educational and research facilities for students entering the railway industry (60—WA-283).



the switch engine to proceed at a slow speed in one direction while the force of gravity accelerates the cars after they are uncoupled (cut) at the crest. As they separate, switches are operated so as to sort them.

A review is given of developments in classification yard design. Criteria are established for minimizing impacts resulting from switching operations. The factors affecting the control of coupling speeds under manual and automatic operation are examined and the means for applying automatic control are described. Recommendations are made for achieving the best utilization of yard design and control equipment. Further investigation of factors affecting the uniformity of car performance is proposed.

Tests of Cushioned Meat Racks in Refrigerator Car Service..60—WA-279... By W. H. Cyr, Canadian National Railways, Montreal, Quebec, Canada. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

For many years, North American Railroads have been trying to eliminate the damage to dressed beef that occurs during shipment in refrigerator cars. The dressed beef is commonly carried suspended from wooden meat rails that run the length of a refrigerator car. Before loading, the beef carcasses are cut into four portions—two front quarters and two hind quarters. Each of these quarters is hung independently from the rails by means of steel hooks. It is not uncommon to find that some of the beef quarters have fallen to the floor and are in a damaged condition on arrival at destination.

The use of the vibration absorber as developed in the paper is an economical and effective solution for elimination of damage to a specific commodity. It is easily applied and may, therefore, be considered as a satisfactory short-term solution to the problem of the elimination of damage to hung beef during shipment in refrigerator cars. This solution is not generally applicable to all loads requiring protection from vibrations sustained in transit.

Originally it was believed that impacts were the cause of downed beef in refrigerator cars and that an underframe cushioning device was necessary to prevent such damage. This study indicates that the real cause is probably inadequacy in truck design. Therefore there is an urgent need for improvement in the riding qualities of existing freight-car trucks, particularly in the higher speed ranges, so that all fragile commodities may be protected adequately.

A New Concept—Push-Pull Suburban Cars..60—WA-264... By William Van Der Sluys, Mem. ASME, Pullman-Standard, a division of Pullman, Inc., Hammond, Ind. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Many new car-building techniques developed for the ultralightweight train activities of the mid-1950's have been successfully applied to the construction of bilevel suburban cars.

In spite of the fact that none of these lightweight trains is being used in the intercity service for which they were originally designed, a great many of the design and building techniques so developed have had a major part in the successful design of the latest type commuter train.

At first glance, it is difficult to see any similarity between the low-height, lightweight cars built for Train X by Pullman-Standard and the double-deck, gallery type suburban cars recently put into push-pull operation by the Chicago and North Western Railway Company. In the former case, the cars are 48 ft and 51 ft long, 11 ft high, and average 30,400 lb. In the latter case the cars are 15 ft 10 in. high, 85 ft long, and weigh approximately 124,000 lb. Still, the result has been the construction of steel suburban cars which, with a somewhat closer seat spacing, have an empty weight/seat ratio in the lightweight train category (766 lb/seat versus 700 lb/seat).

The outstanding development on these cars is, of course, the push-pull operation, whereby the locomotive is always at the same end of the train, pushing the cars into Chicago on inbound runs and pulling them on the outbound runs.

The author concludes that while the dearth of orders in the passenger-car field in recent years has prevented any

large-scale activity, there have still been sufficient developments in many aspects of car construction to permit the building of a new fleet of commuter cars which not only supplies superior comfort and convenience to the commuter, but which also provides such economies in operation and maintenance as to point the way toward a return of the commuter business to a profitable operation.

The Design and Development of the General Electric FVDL-16 Engine..60—WA-272...By J. C. Rhoads, Mem. ASME, General Electric Company, Erie, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The basic design of the FVA series of 6, 8, 12, and 16-cylinder engines was made in the early 1940's by the Cooper-Bessemer Corporation. Preliminary development work was completed by the end of World War II and the first 6-cylinder engine commercially applied on a General Electric locomotive. The original engine rating was 110 gross horsepower per cylinder, which is equivalent to 131 lb BMEP. While the original design called for speeds up to 1300 rpm, the early engines were run at 1000 rpm and this has continued to be the operating speed.

The basic engine design was very well conceived, and many basic features have been retained, including the integral head and cylinder arrangement; the 4-valve head, with the two intake valves outboard and the two exhaust valves inboard; the cast-iron piston; the bolted piston pin; the cast main frame; and, for V-type engines, the master and link-type articulated connecting-rod system. However, in the course of development following the introduction of the prototype 6-cylinder engine, the design of practically every part has been changed or modified.

Nevertheless, the basic design concept was so sound that, without alteration of any fundamental engine dimension, ratings have been steadily raised to the present value of 204 lb BMEP. This represents an increase of over 50 per cent. Design changes that achieved these objectives are discussed, and experience gained in both laboratory and field testing is described. The advantages of the present design are examined in the light of both operation and maintenance requirements.

Aviation

Investigation of Gas Turbine as a Prime Mover in Petroleum Servicing Industry..60—WA-292...By Don H. Hathorn and Joe K. Arnold, Halliburton Company, Duncan, Okla. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In the petroleum industry there are numerous service companies whose primary business is to provide mobile pumping equipment directed to the drilling and completion of oil wells. In this type of service the weight of each component part of the pumping equipment is of extreme importance owing to the fact that it is transported over the highways to each job; therefore, it must be within legal highway weight limits.

With their low weight per horsepower ratio, gas-turbine engines appear attractive provided these engines can fulfill the other necessary requirements of this type service. Both mechanical and economical requirements of such an application are discussed. A prototype installation is currently undergoing evaluation tests.

Low-Thrust Propulsion for Mars Transfer Missions..60—WA-295...By Harold Brown, Assoc. Mem. ASME, General Electric Company, Evendale, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The use of low-thrust electrical propulsion for Earth-Mars orbit-to-orbit transfer missions is investigated for the purpose of identifying propulsion-system design requirements and performance capabilities. The Earth-escape transfer and Mars-capture phases for both minimum energy "freight" missions and "fast" minimum transfer-time missions are discussed in detail. Calculations were performed with the aid of a four-body, three-dimensional, numerical-integration, digital-computer code. Thrust and orbit orientation and propulsion-time requirements for each mission phase are identified.

It is shown that significant improvements in payload capabilities can be achieved by electrical propulsion systems with total-mission transfer times comparable to those required for conventional rocket systems.

Ultra-High Pressure Physics..60—WA-331...By William G. Field, U. S. Air Force, L. G., Hanscom Field, Bedford, Mass. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Several ultrahigh pressure effects of interest to mechanical engineers are discussed together with their physical basis. The preparation of several new materials is given and methods of evaluating material properties are described. The future of high pressure is considered.

The range of pressures discussed extends to approximately 125,000 bars. A pressure of 125,000 bars is equivalent to approximately 2 million lb per sq in., or to the pressure found in the earth at a depth of about 250 miles. While such high pressures have been available for some years, it was not possible to simultaneously achieve the high temperatures necessary for fundamental research. Recently developed equipment not only produces extremely high pressures, but also permits the simultaneous application of temperatures in excess of 3000 C.

While equipment is now available for the generation of extremely high pressures and temperatures, techniques for the evaluation of pertinent material parameters are not, in general, available. The development of such techniques will be an important part of high-pressure research during the next few years.

Large Radar-Antenna Servodrive Employing High-Horsepower, Eddy-Current Clutches..60—WA-302...By W. L. Hinks, Assoc. Mem. ASME, and D. L. Brown, Goodyear Aircraft Corporation, Akron, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The large antenna structures being developed for antimissile use, space-vehicle tracking, and radio astronomy have introduced new problems in the art of servomechanisms. Typical problems are high-precision requirements, high horsepower for rapid acceleration or for countering wind torques, and resonance problems resulting from the combination of large controlled masses and structural compliance.

The design of a servodrive for a large radar-antenna synchronizing system is described. Emphasis is placed on the problems associated with this type of system, including high-horsepower requirements, high-angular accuracy, gust transients, structural resonance, and high reliability. The development of a servodrive employing two 125-hp eddy-current clutches to fulfill these requirements is detailed. The advantages and disadvantages of such a system are noted.

Aspects of Heavy Press Utilization..60—WA-317...By Jacob Brayman, Engineering Supervision Company, New York, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Since the inception of the Air-Force heavy press program, and its remarkable success in the field of closed-die forging and cylindrical billet extrusions, it has become apparent that the capabilities and scope of the presses could be expanded greatly to cover a wide range of materials and configurations by the addition of auxiliary tooling and equipment such as

mechanical handling and heating auxiliaries. The results of studies and application of presses to production of a variety of shapes and materials are given.

Discussed are the production of integrally stiffened panels, the possibility of using rubber pads for deep drawing on large presses and the use of the right-angle forging arrangement, the use of extrusion presses for producing large flat panels, and the production of sandwich and honeycomb configurations, and of tank hull components.

Automatic Checkout Equipment on Military Aircraft..60—WA-330...By R. G. Lohmann, PRD Electronics, Inc., Brooklyn, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

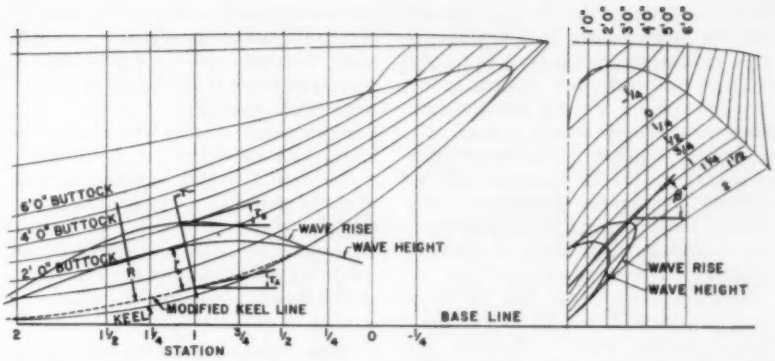
The aircraft maintenance levels in which automatic checkout equipment functions are discussed. The need for full awareness of the maintenance tasks on the part of airborne and ground-equipment designers is stressed. Discussed are some criteria for choosing equipment, the tactical situation, time available for the maintenance task, and the over-all economy of automatic checkout for a weapon system. The application of automatic checkout in the W2F-1 and A2F-1 is briefly described in relation to the levels of maintenance. Although the W2F and the A2F utilize widely different organizational equipment, the field checkout system is similar. In some cases it is identical.

The author concludes that automatic checkout for military aircraft can be applied to achieve turnaround times considerably less than could be obtained by use of manual testing.

Determination of the Modes of Vibration of a Single-Barrel Rocket-Engine System When Vertically Mounted on a Test Stand ..60—WA-323...By W. B. Small and R. A. Hinker, Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A description of the means employed to systematically reduce into the form of a dynamic matrix the elastically mounted mass elements of a liquid-propellant rocket engine is given. Energy relationships are used. The method is illustrated by a numerical example, and the system mode shapes and frequencies are determined.

The method described has the property of being capable of modification so as to incorporate the effects of the replacement of the rigid mass elements considered here with deformable mass elements. Enlargement of the dynamic model is possible so that influences of the attachment of the engine system to an elastic test stand or missile structure can be studied.



The hull of a high-speed open-water hydrofoil boat encounters severe wave impacts. This set of lines closely delineates the form in the impact area of such a hull. Wave height and rise lines correspond to a 100-ft harmonic wave, 12 ft from trough to crest (60—WA-326).

Hydrofoil Boat Hull-Wave Impact Loads..60—WA-326...By William R. Jensen, Grumman Aircraft Engineering Corporation, Bethpage, L. I., N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A method is presented for calculating the hydrodynamic loads that result when the hull of a hydrofoil boat traveling at high speed enters an especially high wave. The theory is based on the same theory used by NASA in its work on seaplane impact loads. In the present effort, the hull is limited to uniform horizontal motion. An acceleration term is nevertheless introduced because of consideration of longitudinal curvature of the bow and the orbital motion of the water.

As an example, impact pressures have been obtained for a 110-ft hydrofoil boat hull. The boat speed, wave height, and relative position of the hull and wave have been selected to produce a severe load consistent with proposed operating conditions.

The only applicable test data available are for rough-water impact of prismatic, V-bottom hulls at constant trim angle. While these hulls lack the feature of longitudinal curvature, the method does give reasonable agreement for this special case.

The impact formulas presented are sensitive to small changes in value of the angles and lengths as measured from the lines. The author concludes that all such measurements should be plotted for the various stations and faired-curve values used to minimize errors. The procedure can be extended to include more complex motion of the water surface and the hull. Such modifications are not justified without a more thorough experimental verification of the proposed procedure.

Turboshaft Power for Marine Propulsion ..60—WA-332...By G. A. Hardgrove, Mem. ASME, General Electric Company, Cincinnati, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Described is the design program that has been carried out in preparation for the manufacture of a turboshaft engine for marine applications. During the earliest design phases of the J79 engine, conceptual designs were studied on the means of converting the available exhaust energy from the basic gas generator into shaft horsepower or additional propulsive thrust by use of a turbofan. The turbofan concept was designed, tested, and proved and is now in production as the commercial CJ805-23 aft turbofan engine. The General Electric Model 240 turboshaft engine includes the advanced technology, performance capabilities, and lightweight structure incorporated in the basic J79 turbojet engine and in the CJ805-23 aft turbofan engine.

The initial application will be as prime power for a hydrofoil vessel, where lightweight and high performance are significant requirements. The hydrofoil craft is analogous to an aircraft with respect to weight and performance. An increase in propulsion system weight, which does not improve performance, will result in a corresponding decrease in the useful load that the vessel can carry.

It is estimated that the installation of the engine can be accomplished in a relatively short time due principally to the ease with which it can be handled and the integrated systems that are a part of the engine assembly.

The Filament-Wound Pressure Cylinder ... A State of the Art Report..60—WA-320 ...By Richard E. Young, Hercules Powder Company, Wilmington, Del. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The glass-fiber filament-wound structure is now accepted as the primary con-

tender for the position of most efficient structural material for this application on a weight-strength basis. The early development work was undertaken by very few workers, whereas now there are many investigators studying practically all areas of this field. This paper seeks to re-examine the fundamentals and to compare continuous filament netting structures with corresponding homogeneous structures, as applied to pressure cylinders, for strength and stiffness.

Structural performance data are tabulated and discussed for the simple cylindrical pressure vessel. Machines for fabricating this composite structure are discussed in principle.

It is concluded that the filament-wound pressure cylinder with integral ovaloid ends represents an efficient means for the application of high-strength filamentary material to pressure vessels. Although this structure appears to be disadvantageous as compared with a solid structure of the same material at the same strength, many materials exhibit sufficiently superior properties as fine filaments to overcome this condition. Candidate filament materials may be selected on the basis of specific strength and stiffness.

The over-all strength-to-density ratio of nearly two million for Spiralloy is considered superior to that of other structural materials and the demonstrated reliability should permit the utilization of this unique composite material.

Lateral Frequencies of Vibration of Helical Extension Springs..60—WA-319... By Joseph C. Dunn, Grumman Aircraft Engineering Corporation, Bethpage, L. I., N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An analytical method is developed that enables the mechanical designer to calculate the natural frequencies of lateral vibration for uniform, axially loaded, round wire, helical springs with a reasonable degree of accuracy. The proposed theory of small transverse oscillations develops along classical lines, employing an equivalent shear-deformation, beam-column element as a mathematical model. Characteristic frequency equations are evolved from the governing differential equation for fixed-fixed and pinned-pinned end conditions. Analytically explicit frequency solutions, however, are arrived at only for the latter case.

A crude graphical frequency-solution technique for the fixed-fixed characteristic equation is suggested in order to illustrate the type of approach required. Representative plots comparing an analytically predicted dimensionless fundamental-frequency parameter against experiment have been constructed for pinned-pinned end restraints and lend credence to the theoretical method.

Power Test Codes

The Polytropic Analysis of Centrifugal Compressors..60—WA-296... By John M. Schultz, Mem. ASME, Borg-Warner Corporation, York, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

The real-gas equations of polytropic analysis are derived in terms of compressibility functions X and Y which supplement the familiar compressibility factor, Z. A polytropic head factor, f, is introduced to adjust test results for deviations from perfect gas behavior. Functions of X and Y are generalized and plotted for gases in corresponding states.

The author says in conclusion that the ASME Power Test Code for Centrifugal, Mixed Flow, and Axial Flow Compressors and Exhausters (PTC10-1949) should be rewritten to include polytropic analysis and equivalent performance testing. The present code is based upon isentropic analysis and therefore cannot provide for equivalent tests.

Efficiency Determination of Marine Boilers: Input-Output Versus Heat-Loss Method..60—WA-298... By L. Cohen, Assoc. Mem. ASME, and W. A. Fritz, Jr., U. S. Naval Boiler and Turbine Laboratory, Naval Base, Philadelphia, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

At the Naval Boiler and Turbine Laboratory boiler efficiencies are determined simultaneously by the input-output and heat-loss methods. This paper discusses the procedures followed in testing boilers for efficiency, and the results and relative merits of the two methods. Naval boilers are described as well as the instrumentation and weigh systems utilized in efficiency determinations. Results from over 200 tests performed on some 35 boilers are used as the basis for comparison between input-output and heat-loss efficiency.

The Effect of Measurement Errors on the Accuracy of the Steam Generator Efficiency Calculation..60—WA-301... By John H. Born, Jr., Foster Wheeler Corporation, New York, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An effort is made to establish how the errors associated with present-day instruments affect the steam-generator efficiency calculations. It is based upon a simplification of error equations. The effects of radiation have not been considered since this loss is determined from charts that are a function of unit design and operating load. The accuracy of this method is not discussed. Of principal interest is the comparison of the accuracy of the input-output heat-loss method of efficiency calculation.

A Generalized Approach to One-Dimensional Gas Dynamics..60—WA-300... By Robert P. Benedict and William G. Steltz, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

The authors recognize and apply certain general concepts toward the uniform treatment of simplified, one-dimensional, steady, workless flow processes.

The problem is approached by combining the concepts of continuity and the critical state to arrive at a generalized compressible flow function, Γ. The authors consider a real gas (one having viscosity and thermal conductivity) whose equation of state is well represented by the relation $p/\rho = gRT$ and whose specific heat capacity at the constant pressure (c_p) is taken as a constant. It is shown how the usual flow processes may be viewed as special cases of a generalized process. A generalized compressible flow table is developed.

Some Generalizations in One-Dimensional Constant-Density Fluid Dynamics ..60—WA-299... By William G. Steltz, Assoc. Mem. ASME, and Robert P. Benedict, Westinghouse Electric Corporation, Lester, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

A generalized constant-density flow function, Γ', which is shown to have direct application in the treatment of many simplified, workless, one-dimensional flow processes, is presented. Those particular flow processes treated in this paper are: (*a*) The familiar adiabatic flows, with or without friction, with area variations always allowed; and (*b*) diabatic flows with or without friction with area variation always allowed. Moreover, the Γ'-function is shown to have significance in a generalized flow process having an arbitrary combination of heat transfer, friction, and area and elevation variation. Development of the Γ'-function is given in some detail. Schematic isentropic, Fanno, Rayleigh, and isothermal flow maps are presented in terms of the conventional enthalpy-entropy and pressure ratio Γ'-diagrams.

Fuels

Effect of Combustion Conditions on Nitrogen Oxide Formation in Boiler Furnaces..60—WA-334... By J. D. Sensenbaugh, Mem. ASME, Combustion Engineering, Inc., Windsor, Conn., and James Jonakin, Mem. ASME, Combustion Engineering, Inc., Chattanooga, Tenn. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In the early stages of investigation of the smog problem in Los Angeles, the mechanism of the smog formation was not understood. In 1952, Haagen-Smit suggested that a series of photochemically initiated reactions between hydrocarbons and oxides of nitrogen might be responsible for the observed phenomena. Since then, numerous studies have confirmed this mechanism for the production of photochemical smog.

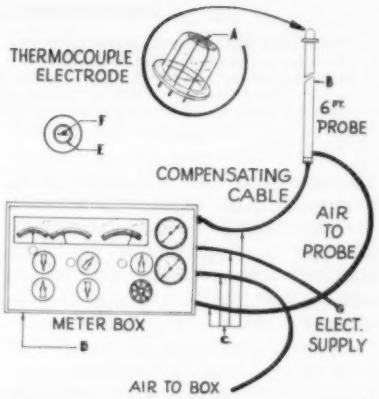
The oxides of nitrogen entering into the smog-forming reactions originate in combustion processes of all kinds. The proportion attributable to power plants has been estimated as 24 per cent of the total nitrogen-oxide emissions in Los Angeles County. Various authors have shown that the emission of oxides of nitrogen from power boilers is significantly affected by altering certain operating conditions. This paper is a progress report on the present understanding of the effect of combustion conditions on nitrogen-oxide formation in boilers. Field and laboratory studies are reported.

Although the laboratory studies are incomplete, it can be concluded from the results obtained to date that the data can be used as a guide for the design of burners for minimum production of oxides of nitrogen.

Dewpoint Meter Measurements in Boiler Flue Gases..60—WA-285... By A. W. Black, Assoc. Mem. ASME, C. F. Stark, Mem. ASME, and W. H. Underwood, The Air Preheater Corporation, Wellsville, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

There has long been needed in American furnace operating practice a practical means of rapidly measuring the tendencies of flue gases to form deposits of flyash or to cause corrosion in such heat-recovery equipment as air preheaters and low-level economizers. This paper discusses the measurements made in eleven American central station steam power plants by a dewpoint meter as originally designed by the British Coal Utilization Research Association to estimate these tendencies.

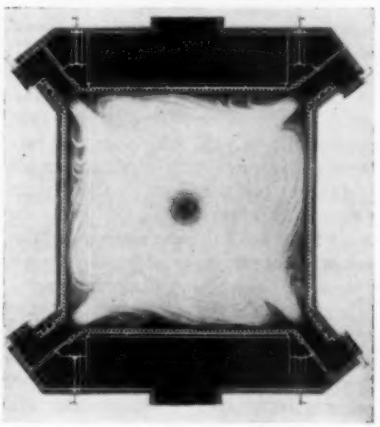
The meter consists of a glass-detector element mounted on a probe with connecting leads and a meter box. The glass-detector element, which is thimble shaped, contains a circular electrode, which surrounds a central electrode. The central electrode also serves as a thermocouple. The surfaces of both electrodes are flush with the outer surface of the glass thimble. The surface temperature of the thimble is controlled by a cooling flow of compressed air which is carried through a tube inside the probe. The probe also carries the lead wires from the electrodes to the meter box.



A British Coal Utilization Research Association dewpoint meter consists of a glass-detector element **A** mounted on a probe **B** with connecting leads **C** and a meter box **D**. The surfaces of both electrodes **E** and **F** are flush with the outer surface of the glass thimble. A film of electrically conductive materials is condensed on the glass surface between the two electrodes and permits alternating current to flow (60—WA-285).

When a film of electrically conductive material is condensed on the glass surface between the two electrodes it completes an electrical circuit and permits alternating current to flow. The magnitude of the current which is measured by the microammeter in the meter box is determined by the value of the externally impressed voltage and the resistance of the film condensed on the glass element. The effects on the dewpoint meter measurements of type and sulphur content of fuel, boiler load, boiler slagging, fuel additives, and so on are discussed.

Tangential firing of regenerator waste gas in CO boilers is shown in this sectional plan view through one level of CO burner ports. The impinging action of the gas and air streams results in thorough mixing (60—WA-327).



Tangential Firing of Regenerator Waste Gas in CO Boilers..60—WA-327... By J. G. Singer, Assoc. Mem. ASME, Combustion Engineering, Inc., Windsor, Conn., and S. S. Blackburn, Jr., Combustion Engineering, Inc., Chattanooga, Tenn. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Catalytic regenerator waste gas, a low heating value fuel which up until ten years ago was considered uneconomical, if not impossible, to burn, is now being fired in over forty steam-generating units.

Commonly known as the CO boiler, these units were designed for full steam flow when fired either by stabilized waste regenerator gas (CO gas) or by conventional fuels. The CO boiler, in contrast to the unfired waste-heat boiler, can furnish steam at pressures and temperatures suitable for power generation, for driving mechanical equipment, and for process use. It has proved especially valuable to refinery operators because of its ability to reduce atmospheric pollution by oxidizing the carbon monoxide and hydrocarbon content of regenerator waste-gas streams.

This paper describes the process that produces this waste gas, characteristics of the gas, and the development of an ideal system for oxidizing it, both for the recovery of heat and for the reduction of air pollution. The results of a series of field tests on operating CO boilers to determine minimum supplementary fuel requirements are reported.

Experiments With MHD Power Generation..60—WA-328... By S. Way, Mem. ASME, S. M. DeCorso, Mem. ASME, R. L. Hundstad, G. A. Kemeny, Mem. ASME, W. Stewart, and W. E. Young, Mem. ASME, Westinghouse Research Laboratories, Pittsburgh, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

This is a report on the development of an experimental MHD electrical generator that derives its energy from the combustion of a liquid fuel and oxygen. The fuel burned is a number 2 distillate oil in which a soluble potassium octoate is mixed to increase the degree of thermal ionization in the product gas. The actual generating volume is approximately 125 cu in. and the rating of 10 kw has been exceeded.

The paper describes some of the broad construction features of the generator and problems arising during its operation. Some sections deal with the fuel and combustion systems, fuel characteristics, and the electrical and magnetic

aspects. The theory of MHD power generation in a uniform duct is presented. Results of the experiments are given and actual performance is compared with theory. The paper is illustrated with photographs and sketches of the various components and curves of power and voltage.

The Significance of the Hall Effect for Three MHD Generator Configurations..60—WA-329...By L. P. Harris and J. D. Cobine, General Electric Research Laboratory, Schenectady, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power**; available to Oct. 1, 1961).

The Hall effect is a phenomenon arising when electric currents flow in a conductor subjected to a magnetic field. Then the components of electric field and electric current density in the plane perpendicular to the magnetic field are not parallel, but are displaced from parallelism by a definite angle characteristic of the magnetic flux density and the properties of the conductor. This effect is found in all types of conductors, solids, liquids, and gases, and occurs because the magnetic field exerts forces on moving charged particles in addition to the electrostatic forces caused by electric fields.

Analyses are presented for the influence of the Hall effect on electrical terminal characteristics, generated power per unit volume, pressure gradient, and generator efficiency in three configurations for MHD generators. The results indicate that desirable generator characteristics can be attained when the Hall effect is either negligible or dominant.

The Use of Fuels in the Cement Industry..60—WA-318...By Fred B. Tripp, Portland Cement Association, Skokie, Ill. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Today, the cement industry is the third largest, individual, industrial consumer of coal and accounts for over 2 per cent of total consumption. This is more than that used by either railroads or steel and rolling mills. Coal is but one of three fuels used in the cement industry; and, the other two, natural gas and fuel oil, are being consumed at a faster growing rate than coal.

The three types present their own problems of storing, handling, preparing, and burning, that are unique to the manufacture of cement. Fuel-saving devices such as wasteheat boilers, long rotary kilns, traveling grates, and preheaters have been developed. These are discussed. When compared to the past, results show that improvements are being made in reduction of fuel consumption.

Instruments and Regulators

Frequency Response Analysis of a Hydraulic Servomechanism With Several Nonlinearities..60—WA-45...By J. Vande Vegte, University of Toronto, Toronto, Canada. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A comprehensive method of calculating frequency-response curves for a hydraulic servomechanism with several nonlinearities is given. The individual describing functions of the nonlinear elements are combined to obtain the over-all describing function. A graphical technique is presented which, for a servo with small external load, permits rapid computation of the response at any amplitude and frequency of the sinusoidal input signal. The correspondence of analytical and experimental results is shown to be quite satisfactory.

On the Dynamics of Steam Liquid Heat Exchangers..60—WA-110...By Arvid Hempel, Chr. Michelsen Institute, Bergen, Norway. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

Relatively simple transfer functions are presented for steam/liquid heat exchangers, relating outlet liquid temperature to variations in the steam temperature, the liquid velocity, and the inlet liquid temperature, respectively. The transfer functions are first obtained from the partial differential equations of the system and then simplified. From the simplified expressions the transient response can readily be obtained. In addition, they are of a form easily simulated on an analog computer. Experimental frequency response data are provided. An analog computer proved useful in analyzing phase lag and amplitude ratio in the frequency response measurement.

Identification of Process Parameters by Means of Models..60—WA-121...By Herman Thal-Larsen and Yasundo Takahashi, Mems. ASME, University of California, Berkeley, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Correct identification of process parameters is important for it permits improved control of processes, which are part of a more complicated control schemes such as dynamic optimization. Various techniques have been developed over the years for identifying the process parameters which operate on incoming signals to produce the corresponding outputs.

In many cases the technique consists of applying known signals to a process and analyzing the resultant response mathematically. Often-used input signals are the step, ramp, pulse, square-wave, and sinusoidal functions. They are popular because the results lend themselves readily to mathematical analysis.

Techniques that do not depend for their success on mathematical descriptions of input and output signals have also been developed. These require the use of a physical model that can be altered to match the dynamic behavior of the process under study.

Various experiments performed under actual disturbance conditions and designed to test the model-matching approach of identifying process parameters are described. First and second-order models were matched against first, second, and third-order processes. Oscillatory models were included. Best matching depends upon the noise pattern. If a process is within a lightly damped control loop, gain and phase matching at the natural frequency of the loop will give the best fit model for that condition. For example, results show that it is possible to substitute a 5-sec, single-time-constant model for a second-order process having 2-sec and 0.5 sec time constants that is located within a feedback-control loop without noticeably affecting the closed-loop behavior of the system.

Dynamic Characteristics of Some Valve-Actuator Hydraulic Controls..60—WA-54...By Vee C. Tsien, Mem. ASME, Cleveland Pneumatic Tool Company, Cleveland, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Hydraulic servo design, involving heavy mass load and high-performance valve-actuator mechanism, often calls for some special arrangements to achieve dynamic response and system stability. Professor Shearer proposed the valve underlapping technique for system damping. He also illustrated the physical significance of some parameters such as fluid compressibility, flow gain, k, and pressure modulation constant, C. Mr. T. Y. Feng introduced the unevenly underlapped four-way valve as an extension of Shearer's design. In many hydraulic controls the requirement of built-in damping prevails over the entire valve-spool displacement range. Also, the standby power loss of some servos is strictly intolerable. Therefore several types of control circuit are developed.

This paper compares four types of controls. The derivations of their valve gain and pressure modulation constant are presented. The dynamic characteristics of each type are compared under the same prescribed condition in the numerical example, which lists the relative flow gain and damping capability.

Type I control consists of the basic arrangement—four-way valve and double-acting actuator—with a fixed orifice in the supply pressure passage, just upstream of the valve. Type II control incorporates a set of fixed orifices in the form of the bistable solenoid valve or some other synchronized device. Type III consists of a two-way valve and double-acting actuator, and two sets of fixed orifices. Type IV consists of a four-way valve with underlapped metering orifices and a double-acting actuator.

Bibliography on Diaphragms and Aneroids..60—WA-122...by Lyman M. Van Der Pyl, Mem. ASME, Rockwell Manufacturing Company, Pittsburgh, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A literative survey committee was created by the research diaphragm subcommittee of the Research Committee on Mechanical Pressure Elements to accumulate a list of the outstanding papers and literature on diaphragms and aneroids. This list includes many of the papers listed in the bibliography on "Diaphragms and Aneroids" published previously (ASME Paper No. 55—A-180 by G. H. Lee and L. M. Van Der Pyl) with the addition of some missing papers and some later papers.

The 171 abstracts included in this paper offer an account of the available literature in this field. The abstracts are arranged alphabetically under the name of the author or senior author. A chronological index is also given.

Transfer-Function Derivation and Verification for a Toric Variable-Speed Drive..60—WA-184...By J. L. Harned, P. Sudhindranath, and K. M. Miller, General Motors Corporation, Warren, Mich., and R. J. Roddy, Rensselaer Polytechnic Institute, Troy, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The accurate, continuous control of power in mechanical systems such as antenna positioning drives is almost universally accomplished by either hydraulic or electrical-type transmissions. From a philosophical standpoint, it would seem that a mechanical transmission would be more elemental; use of mechanical power control would eliminate not only two energy conversions but would reduce system complexity. Mechanical drives are now being given serious consideration for certain military applications where severe environmental conditions and performance specifications overtax the capabilities of hydraulic and electric drives.

One type of mechanical actuator that appears to have the performance potential to fulfill high-power control applications requiring good dynamic response and high accuracy is the toric transmission combined with a single or dual-differential split drive.

Basic relationships that control the dynamic performance of toric variable-speed drives are studied. These basic toric relationships are then utilized to derive seven linear differential equations that describe a commercial model of a toric transmission. Experimental verification of these equations is made to support the theoretical work. By means of a numerical evaluation of the transfer functions, a simplified interpretation is made to show the relationships between transmission parameters and dynamic performance.

Dynamic Behavior of a Simple Pneumatic Pressure Reducer..60—WA-186...By D. H. Tsai and E. C. Cassidy, National Bureau of Standards, Washington, D. C. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

An analysis is given of the dynamic behavior of a simple pneumatic pressure reducer. Both the nonlinear and the linearized problems were studied. Some experimental results also were obtained on a working reducer model to check the validity of the analysis. The agreement between the nonlinear solutions and the experimental results was satisfactory. The nonlinear and the linearized solutions were compared in detail so as to bring out the essential features of the dynamic behavior in both cases. The stability problem was studied also, and a set of stability criteria for the linearized case was formulated in terms of the design and operating parameters of the reducer. In the few sample cases studied, these criteria gave correct qualitative predictions of the stability of the reducer in both the linearized case and the nonlinear case. The flow forces on three typical flowmetering values were determined by experimental measurements. These results were used in the analytical part of the paper.

Fluid Mixing in Shell-and-Tube Heat Exchangers..60—WA-261...By George C. Vincent, Monsanto Chemical Company, Springfield, Mass.; Joel O. Hougen, Monsanto Chemical Company, St. Louis, Mo.; and Gerald E. Dreifke, St. Louis University, St. Louis, Mo. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In deriving the mathematical descriptions of the transient behavior of heat exchangers, it has been customary to assume either that the fluids are exceedingly well mixed or that no mixing at all occurs. These assumptions, made in the interest of simplifying the physical picture and associated mathematics, make difficult a rational interpretation of experimental data since intuitively it is known that neither assumption is descriptive of the actual situation. Fluid mixing does occur in heat exchangers, but to what extent has not been reported.

The objective of this work was to measure the mixing that takes place in the flowing fluid streams of a multipass tube and shell type heat exchanger.

A simplified mathematical description of longitudinal mixing in the fluid streams of heat exchangers has been employed. It indicates that the nondimensional group, $\pi L/4D$, is the significant parameter. By comparison of experimental data with computed curves in the frequency domain, mixing parameters were evaluated for a small industrial tube-and-shell heat exchanger at a number of flow rates. A method of predicting average residence times for each stream is also presented.

Petroleum

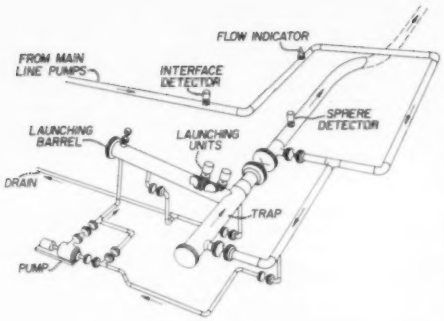
Deflection of Heat Exchanger Flanged Joints as Affected by Barreling and Warping..60—WA-70...By W. M. Dudley, Mem. ASME, Standard Oil Company (Indiana), Whiting, Ind. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

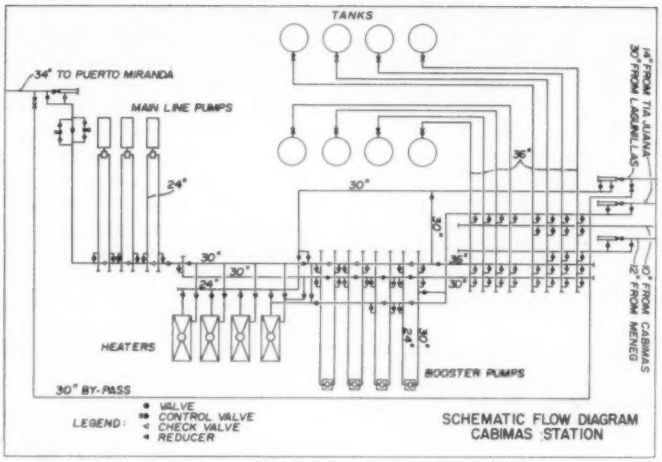
The conventional formulas for bolted-flange design, given in the ASME Unfired Pressure Vessel Code, provide for stresses due to initial bolt tightening and the axial force of internal pressure. Additional forces tending to loosen a joint are created by unequal radial expansion or barreling of the flange and shell, due to temperature differences or pressure, and by unequally warped flanges.

Formulas have been developed for the extra bolt loads required to overcome these effects and applied to a heat-exchanger joint in a catalytic reforming unit. The margin of safety against leakage is increased by using soft gaskets that can re-expand after being compressed, and by retightening bolts after operating temperatures and pressures are reached. Joints designed to resist initial bolting and hydrostatic forces only are likely to leak because of barreling effects or warped flanges.

Constant Cross-Section Fin Efficiencies for Nonuniform Surface Heat-Transfer Coefficients..60—WA-41...By L. S. Han and S. G. Lefkowitz, The Ohio State University, Columbus, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Whenever extended surfaces or fins are used to increase heat-transfer area, one





Mechanical separation equipment, **above,** is part of facilities of the North Terminal System, a heated crude-oil pipeline and marine terminal on the east coast of Maracaibo, Venezuela. Separation spheres are launched with the aid of pins, as shown. At **right** is a schematic of the system pump station at Cabimas. Crude oil entering the station is directed either to tankage or to the main line pumps through heaters (60—WA-42).

effect is to produce a nonuniform convective heat-transfer coefficient along the fin length. Previous investigations to determine the fin efficiency were based on the assumption of a uniform heat-transfer coefficient. This paper studies the effect of a power-function type variation of the heat-transfer coefficient on fin performance. The results indicate appreciable error when calculated on the basis of a uniform surface coefficient, particularly at large values of the fin parameter.

A Further Reappraisal of Balanced Pressure-Vessel Construction and Classification..60—WA-313... By J. J. Murphy and D. B. Rossheim, Mems. ASME, M. W. Kellogg Company, New York, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The demonstrated advantages of and the necessity for rationalizing structural design, which is leading to the plastic analysis of structures, is paralleled with respect to pressure equipment by continuing efforts to evolve a broader and more realistic association of stress evaluation with material potentials. A previous paper "Economic But Safe Pressure-Vessel Construction," Welding Research Council Bulletin No. 27, May, 1956, suggested three classes of construction, each a balanced association of material, design, fabrication, and inspection.

This paper reflects the intervening further thinking and contribution to this subject. It constitutes a current reappraisal of balanced-pressure equipment, with an additional class of fully examined construction to permit economic advantage from somewhat less than optimum details, whose ultimate refinement involves considerable added cost. An attempt is made to crystallize fundamentals and basic approach. A companion paper, "Suggested Design Requirements for an Improved Pressure Vessel Code," develops detailed design requirements for an improved pressure-vessel code.

Design and Operation of a Heated Crude Oil Pipeline and Marine Terminal..60—WA-42... By W. P. Binger, Assoc. Mem. ASME, Compania Shell de Venezuela, Maracaibo, Venezuela. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The author's company has completed the design and has in operation the major portion of a large-diameter heated crude-oil pipeline and marine terminal on the east coast of Lake Maracaibo, Venezuela. This system consists of three pump stations, a 30–34 in. pipeline, and a marine shipping terminal with a capacity of over 500,000 barrels of crude daily.

The hydraulic and mechanical design of the system is outlined along with a brief description of an IBM 650 computer program developed by Compania Shell de Venezuela which will calculate hydraulically a heated oil pipeline system carrying several crudes. The actual operation of the system is described and a preliminary comparison made with the calculated design of the system.

Suggested Design Requirements for An Improved Pressure Vessel Code..60—WA-321... By C. A. Honigsberg, Assoc. Mem. ASME, and G. P. Eschenbrenner, Mem. ASME, The M. W. Kellogg Company, New York, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A companion paper, "A Further Re-Appraisal of Balanced Pressure Vessel Construction and Classification," has developed the fundamentals and basic approach to balanced pressure equipment. This paper attempts to elaborate and expand on the design requirements and to apply the basic approach to a simple, workable code. Except for critical vessels of the highest quality, the use of the suggested design requirements would be similar to, or even simpler than, the present ASME Unfired Pressure Vessel Code. The application of these requirements, which are derived from a rational basis, will result in pressure vessels which, when compared to those designed by present codes, are both safer and more economical.

The authors believe that the design requirements in the proposed code for each of the four vessel classes should be published in separate sections with no interdependence among them. Once the appropriate class for a given vessel has been determined, based upon the user's specification, the designer should find all the rules for that class in one place.

In this paper, however, in order to assist the reader in understanding what the authors are proposing, a summary of the design rules is given in tabular form. This will also be helpful in permitting comparisons among the four classes of the requirements for any particular component. Furthermore, the table refers to acceptable design details which are shown only once in a group of figures following the table.

The Yielded Compound Cylinder in Generalized Plane Strain..60—WA-71... By S. J. Becker, Westinghouse Electric Corporation, Bettis Atomic Power Laboratory, Pittsburgh, Pa. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

The theory of a previous paper "An Analysis of the Yielded Compound Cylinder," ASME Paper No. 60—SA-13, which was designed for plane strain of a compound cylinder, is extended to generalized plane strain, where the axial strain is a constant nonzero value for every radius and depends only on the

external and internal pressures and any extraneous axial load. The method is limited to incompressible elastic material and is found to be completely solvable only if an elastic zone exists in each component. The assumed Tresca yield condition is verified in the process of obtaining the complete solution.

Stresses in a Pipe Bent Into a Circular Arc..60—WA-157... By N. A. Weil, Mem. ASME, Armour Research Foundation, Chicago, Ill.; J. E. Brock, Mem. ASME, U. S. Naval Postgraduate School, Monterey, Calif.; and W. E. Cooper, Mem. ASME, General Electric Company, Knoll Atomic Power Laboratory, Schenectady, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

The stress distribution in circular bends formed from straight pipe and subjected to internal pressure is presented. The analysis determines first the thickness distribution after forming, followed by an examination of the validity of membrane solutions for a complete torus. The predicted thickness distribution is in excellent agreement with experimental results as well as with three previous empirical formulations. The analysis shows that stresses in curved bends will always exceed the governing hoop stress in a comparable straight pipe, the deviation becoming greater with increased corrosion allowance. The authors recommend that, for purposes of acceptance by the ASA B31 Code, an excess stress level of the order of 5 per cent be allowed to develop in pipe bends. The resulting bend radius to pipe diameter limitations are listed.

Thermal-Stress Analysis of Irregular Shapes..60—WA-131... By P. P. Bijlaard, Cornell University, Ithaca, N. Y., and R. J. Dohrmann, Assoc. Mem. ASME, The Babcock & Wilcox Company, Alliance, Ohio. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

A method has been developed for determining the thermal stresses resulting from an axially symmetric temperature distribution in an irregularly shaped cylindrical vessel. It permits the calculation of the principal stresses, rotations, and displacements for all points within the cross section and on the boundary of the geometry being considered. An example is given for which the "isostress" and isothermal lines are plotted for an irregular geometry with varying temperature gradients.

Maintenance and Plant Engineering

Developing the Scale Model for Factory Construction and Maintenance..60—WA-267... By M. T. Cutrell, Proctor and Gamble Manufacturing Company, Dallas, Texas. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Two-dimensional drawings cannot always convey in simplest form the information required for a project and may be the cause of many points of doubt and misunderstanding between the drafting room and shop. This can result in errors, delays in planning and scheduling, and difficulty in evaluating alternatives. The latter affects capital investment, expansion, operating costs, maintenance, and so on. Management time is spent in evaluation of these phases. The best engineering presentation appears to be the scale-model procedure developed by the author's company into a practical working tool. Selection and training of personnel for model work, model-shop facilities, and economics of model procedure are discussed.

It is concluded that the use of models on plant-maintenance and construction activities are useful in the following ways:

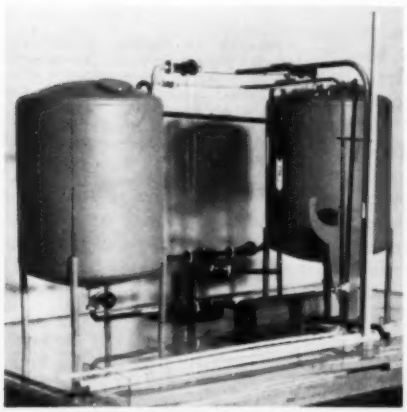
1 Translation loss in the engineering and completion of a plant-level project can be greatly reduced by use of scale models.

2 A scale model when supplemented by dimensioned photographs of the model makes a very clear and economical engineering presentation for field work on a project.

3 With proper choice of personnel, tools, and shop site a modeling program can be initiated by a single plant on a reasonable cost. For example, initiation of a program by one plant cost $930 for training and $545 for shop facilities.

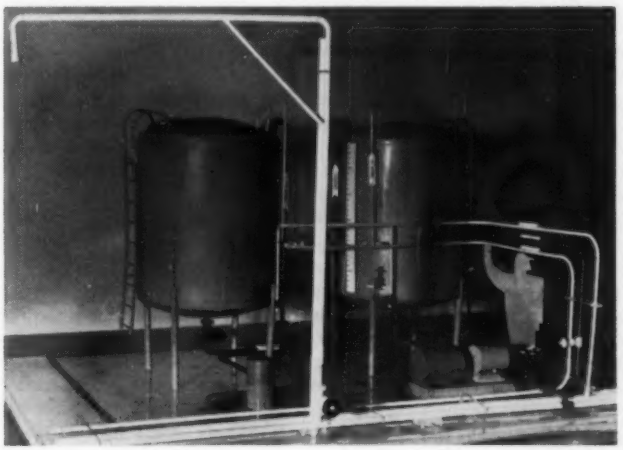
A Patent Problem Deriving From Machine Maintenance..60—WA-266... By Bryce Beecher, General Motors Corporation, Detroit, Mich. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The patent grant confers the right to exclude others from making, using or selling the invention to which the patent is directed. When one purchases a patented machine he, of course, obtains



Before—A model layout of a railroad tank car wash system looked like this

After—Management review added pipe to the model that was prefabricated from model dimensions. No drawings were used. Models of plant projects combined with photodrawings provide an effective and economical technique of dimensional-data presentation. They may replace large numbers of blueprints on some plant projects in the future (60—WA-267).



an implied license to use the machine. He also obtains the right to dispose of it, as by resale, should the time arrive when he has no further need of it, and he is permitted to make reasonable repairs as necessary to keep the machine in working order. The right to use and to repair, however, in the absence of an express agreement does not include the right to reconstruct, for the implied license attaching to the purchase does not include a license to make the machine.

The paper covers in a general way this aspect of patent law, which bears particular relation to the plant engineer.

The Role of Ultrasonic Testing in Maintaining Superheaters Subjected to Fireside Corrosion..60—WA-338... By Jesse W. Jacob, Electric Energy, Inc., Joppa, Ill. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The six boiler-turbine generators of the Joppa Steam Electric Station have a gross daily capability of 1,050,000 kw, each boiler operating at 1,200,000 lb per hr steam flow at 2050 psi drum pressure and 1050 F at the turbine; reheat is to 1000 F. The corrosion problem considered in the paper is found on the exterior or fireside of the finish superheater and reheater tubes. Following the discovery of this problem, a large-scale attempt was made to measure the corrosion suffered in all units up to that time and to establish a rate of corrosion. Results are given from various methods of determining wastage of tubes and eventually from applications of an ultrasonic testing device.

Fluid Meters

Expansion Coefficients for Orifice Meters in Pipes Less Than One Inch in Diameter ..60—WA-137... By G. A. Marxman and H. Burlage, Jr., Case Institute of Technology, Cleveland, Ohio. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

A practical technique for using orifices to meter most gases of engineering interest is described. This technique can be employed in pipes less than 1 in. ID, as well as in larger sizes. An analytical expression for the orifice expansion coefficient is developed; this expression includes an empirical factor based on published data for orifice installations in pipes two or more inches in diameter. Experimental verification has shown that the equation gives correct results for the smaller systems and in gases with a specific heat ratio other than 1.3 or 1.4. It is also shown that the empirical equation for orifice-expansion coefficients which appears in the ASME Fluid Meters Report entitled "Fluid Meters—Their Theory and Application," can be used over a range that includes most gases as well as pipe diameters as small as $\frac{1}{4}$ in.

Gas-Tracer Method of Steady and Pulsating-Flow Measurement..60—WA-142... By J. F. Kemp, National Mechanical Engineering Research Institute, South African Council for Scientific and Industrial Research, Pretoria, South Africa. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

A method is described of measuring the bulk mass-flow rate in steady and pulsating air streams with the aid of a suitable tracer gas such as carbon dioxide. The method briefly involves controlled injection of the tracer into the main flow, mixing of the two flow media, and analysis of the mixture to determine the concentration of the tracer. The main flow is derived from the injection flow rate and from the concentration of the tracer in the sample mixture. An inexpensive infrared analyzer was constructed for determining mass concentrations of carbon dioxide in air ranging from $\frac{1}{2}$ to 3 per cent. Results obtained by the gas-tracer method in both steady and pulsating streams were compared with those obtained by other methods of mass-flow measurements. A few possible practical applications of the measuring technique are discussed.

Flow Measurement for Accounting Purposes..60—WA-141... By D. D. Livingstone, Polymer Corporation Limited, Sarnia, Canada. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The operation of petrochemical plants "across the fence" from petroleum refineries that supply raw materials has required that accurate measurement of such streams be provided for accounting purposes. Operation of Canada's synthetic-rubber plant in Sarnia, Ontario, depends upon the exchange of such streams with three adjacent refineries. Over twenty such streams are measured by thin-plate orifice-meter installations incorporating two orifices in series. The purpose of this study was to analyze the results achieved over a period of 5 years in order that precision of metering could be calculated and an estimate made of over-all accuracy.

The study reviews the results obtained in metering five light hydrocarbon gas flows, ten light hydrocarbon liquid flows, and six superheated steam flows for the five-year period 1954 to 1958. The hydrocarbon streams included mixtures containing a range of hydrocarbons from methane to pentane and also relatively pure streams such as commercial grade ethylene and butadiene. The steam flows were either 150-psi or 400-psi steam with approximately 150 F of superheat.

Oil and Gas Power

Diagram for Conversion of Diesel Engine Outputs for Changed Atmospheric Conditions..60—WA-162... By Soren Hansen, Burmeister and Wain's, Copenhagen, Denmark. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power**; available to Oct. 1, 1961).

The diagram treated in this paper emanated from the work in a committee appointed by CIMAC for drafting recommendations for the testing of diesel engines. During this work it proved desirable to establish that the outputs stated in contracts and specifications must always be the outputs the engines are to develop in their places of service—that is, for example, on the site at high altitudes for stationary engines and under tropical conditions in the case of engines for ocean-going ships.

A single reference line in the diagram corresponds to a given atmospheric condition. The use of tables and graphs prepared for each particular atmospheric condition is thus eliminated. By means of the diagram it is easy to convert a specified engine output into an output under the conditions existing during the testing in the engine builder's workshops, and thus establish that the output stated for the engine is the output which the engine, according to the contract or specification, is to develop in its place of service.

Research on Charge Stratification of Spark-Ignition Engines..60—WA-314... By Lewis D. Conta, Mem. ASME, and Pandeli Durbetaki, Assoc. Mem. ASME, The University of Rochester, Rochester, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Although the idea of stratification is old, the development of a method to accomplish it successfully is not easy. Two basic methods have been tried in the past; one involving a nonhomogeneous charge in a single cylinder, and the other employing two relatively homogeneous charges in two separate but connected chambers.

The latter method is used in the research on charge stratification that has been under way for some time at the University of Rochester. This research has been extended to a third engine—a single-cylinder Palmer RND-1 diesel. The work to date is summarized.

Supercharging of a Large Two-Cycle, Loop-Scavenged Diesel Engine..60—WA-185...By A. J. Henriksen, Mem. ASME, Nordberg Manufacturing Company, Milwaukee, Wis. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

The paper covers the mechanical and thermodynamic aspects of increasing the power output and thermal efficiency of an existing nonsupercharged, two-cycle, loop-scavenged diesel engine through supercharging. The power output was increased by 40 per cent and the thermal efficiency by approximately 4 per cent. Much of the thermodynamic work was done on a UNIVAC computer and a brief description of the theoretical approach and results appear in this paper. Field test results from a Nordberg two-cycle, $21^1/_2$-in. × 31-in. supercharged engine are also included.

ASME TRANSACTIONS

Journal of Engineering for Industry

The May, 1961, issue of the Transactions of the ASME—*Journal of Engineering for Industry* (available at $1.50 per copy to ASME Members, $3 to nonmembers) contains the following:

A New Analytical Approach to Drill Pipe Breakage II, by J. L. Bogdanoff and J. E. Goldberg.

Engineering in Resuscitation, by Benjamin Smilg. (60—WA-196)

A New Test Method for Determination of Spinnability of Metals, by R. L. Kegg. (60—Prod-3)

On the Mechanics of Shear Spinning, by Serope Kalpakcioglu. (60—Prod-1)

On the Analysis of Random Errors in Precision Grinding Operations, by R. S. Hahn. (60—Prod-7)

Machinability of Nodular Cast Irons, Part I, by I. Ham, K. Hitomi, and G. L. Thuering. (60—Prod-8)

A Milling Torquemeter of Planetary-Gear Design, by J. R. Roubik. (60—Prod-5)

Free Machining Steel: I, by M. C. Shaw, N. H. Cook, and P. A. Smith. (60—Prod-2)

Free Machining Steel: II, by M. C. Shaw, P. A. Smith, and N. H. Cook. (60—Prod-4)

Free Machining Steel: III, by M. C. Shaw, E. Usui, and P. A. Smith. (60—WA-111)

An Experimental Investigation of the Electrolytic Grinding Process, by R. R. Cole. (60—WA-2)

Use of a Centrifuge for the Precision Measurement of Accelerometer Characteristics, by S. R. Sporn. (60—WA-195)

Calibration Techniques in Ultrahigh-Pressure Apparatus, by F. P. Bundy. (60—WA-178)

On the Determination of the Influence of an Axial Preload Owing to Bolting on a Cylindrical Pressure Vessel, by P. R. Paslay. (60—WA-133)

Shaft Whirling as Influenced by Stiffness Asymmetry, by E. H. Hull. (60—WA-252)

Optimum Design of Helical Compression Springs, by R. J. Erisman. (60—WA-215)

Journal of Heat Transfer

The May, 1961, issue of the Transactions of the ASME—*Journal of Heat Transfer* (available at $1.50 per copy to ASME Members, $3 to nonmembers) contains the following:

Wall Temperature and Heat Flux Measurement in a Round Tube, by A. I. Morgan, Jr., and Robert A. Carlson. (60—HT-1)

The Viscosity of Steam and Water at Moderate Pressures and Temperatures, by J. R. Moszynski. (60—HT-29)

Thermal Conductivity and Prandtl Number of Carbon Dioxide and Carbon-Dioxide Air Mixtures at One Atmosphere, by Jerome L. Novotny and Thomas F. Irvine, Jr. (60—HT-13)

The Influence of Sound on Free Convection From a Horizontal Cylinder, by R. M. Fand and J. Kaye. (60—HT-14)

A Model for Correlating Two-Phase, Steam-Water, Burnout Heat-Transfer Fluxes, by H. S. Isbin, R. Vanderwater, H. Fauske, and S. Singh.

Burnout in Turbulent Flow—A Droplet Diffusion Model, by K. Goldmann, H. Firstenberg, and C. Lombardi. (60—HT-34)

Forced Convection Heat Transfer From an Isothermal Sphere to Water, by G. C. Vliet and G. Leppert. (60—HT-5)

The Effect of Density Variation on Heat Transfer in the Critical Region, by Yih-Yun Hsu and J. M. Smith. (60—HT-8)

Heat Transfer by a Turbulently Flowing Fluid-Solids Mixture in a Pipe, by C. L. Tien. (60—HT-23)

Heat Transfer and Pressure Drop in an Annular Gap With Surface Spoilers, by G. A. Kemeny and J. A. Cyphers. (60—HT-15)

Radiation Heat Transfer in a Spherical Enclosure Containing a Participating, Heat-Generating Gas, by E. M. Sparrow, C. M. Usiskin, and H. A. Hubbard. (60—HT-9)

Analysis, Results, and Interpretation for Radiation Between Some Simply Arranged Gray Surfaces, by E. M. Sparrow, J. L. Gregg, J. V. Szel, and P. Manos. (60—HT-4)

Radiative Transport Within an Ablating Body, by Leo P. Kadanoff. (60—HT-2)

Radiant Heat-Transfer Analysis of a Furnace or Other Combustion Enclosure, by J. T. Bevans. (60—HT-12)

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1961 American Power Conference—ASME Technical Paper Digests

THE following are digests of the papers presented at the American Power Conference, Sherman Hotel, Chicago, Ill., March 21–23, 1961, at sessions sponsored by the Power and Fuels Division of The American Society of Mechanical Engineers. Cloth-bound volumes of the Proceedings will be available from R. A. Budenholzer, Illinois Institute of Technology, Technology Center, Chicago 16, Ill., at $10 per copy.

Central Stations

Initial Operation of Avon No. 8—A Supercritical Plant..APC No. 4... By Neal F. Gill and Newton D. Flack, Assoc. Mems. ASME, The Cleveland Electric Illuminating Company, Cleveland, Ohio.

The first-year availability record for the 250-mw, 3500-psig, 1100/1050-F Avon 8—the third supercritical-pressure unit in the United States to go on the line—was "not too discouraging." In general, there was more trouble than wished, but less than expected, and in practically all cases the problems have been solved. Out of 21 outages, 13 were attributable to the boiler which was available 80 per cent of the time. Overall availability was 71.2 per cent. Turbine difficulties caused five outages (one of 784-hr duration) resulting in an availability of 91.4 per cent.

Over half of the boiler outages were caused by tube failures. Some of these were due to improper shop welds, but the longer outages were a result of overheating the tube metals. This was caused by inadvertently raising fuel feed to the 240-mw level while water flow was only sufficient for 150 mw. A protective feature will be added.

The thermal performance recorded the first year was not as good as expected because of blade deposits, particularly on the last wheel of the superpressure section, and throughout the very-high-pressure turbine (750 to 2200 psia at full load). Copper oxide predominated in the extremely hard and very adherent deposits. This definitely appears to be a deposition phenomenon especially characteristic of supercritical-pressure conditions and one which occurred despite stringent copper controls. "Elimination of this deposition can become a very formidable problem."

The authors conclude that the second year's operation will be the barometer of the potential of this unit with respect to reliability, capability, and thermal performance.

Supercritical Boiler Experience at Avon No. 8..APC No. 5... By J. I. Argersinger, Assoc. Mem. ASME, and G. C. Smith, Combustion Engineering, Inc., Windsor, Conn.

The experience to date with Avon 8 indicates that the boiler unit is fundamentally sound and will fulfill all reasonable expectations. Comparison of predicted and actual temperature rise in the various components of the boiler primary circuits and the reheater shows close agreement, demonstrating "engineering competence in heat transfer in the supercritical fluid."

Total pressure drop from economizer inlet to turbine throttle is roughly 20 per cent less than predicted, providing adequate margin between actual and expected working pressure. Primary and reheat steam temperatures are maintained at full value down to about 40 per cent load, whereas the guaranteed range of control was from 100 per cent down to 60 per cent load.

The authors state that Avon 8 experience provides a basis for modified, simplified, and improved design for future supercritical units.

Avon Superpressure Steam Turbine Generator Unit..APC No. 6... By C. C. Franck, Sr., Fellow ASME, and J. A. Carlson, Mem. ASME, Westinghouse Electric Corporation, Lester, Pa.

Operation with a Monotube or "once-through" steam generator and the use of ferritic materials at the main inlet steam conditions of 3515 psia and 1100 F are among the unique features of the Avon 8 unit. There has been no evidence of creep or growth in the superpressure-element rotor, and oxidation of all superpressure turbine parts was negligible and less than anticipated. There were no visible signs of erosion of the nozzle vanes or blading of any stages of the superpressure element.

The superpressure element is unusual in having the expansion of steam from the main inlet pressure to the reheat pressure level split into two elements. This was done in order to secure the smallest practicable turbine element which would be subjected to steam pressure and temperature beyond the limit of existing operating experience for ferritic materials.

Breed Plant..APC No. 24... By Philip Sporn, Hon. Mem. ASME, and S. N. Fiala, Fellow ASME, American Electric Power Company System, New York, N. Y.

Breed is the first of two 450-mw commercial supercritical units (Philip Sporn Plant is the other) based on experience gained with the 4500-psi, 1150/1050/1000-F, 120-mw Philo No. 6 unit. It was the largest commercially operating unit anywhere when started. Because of the cost of high-temperature materials, Breed is designed for 3500 psi, 1050/1050/1050 F. Thermal efficiency is expected to be slightly above 40 per cent.

It is in effect a mine-mouth plant (actually 10 miles from the colliery) which uses economical 345-kv single-tower transmission to bring the power approximately 200 miles to Indiana & Michigan Electric Company's service area. It was necessary to go outside the area because fuel and well-endowed plant sites were unavailable there.

The double-reheat steam generator is of the once-through type. Forced flow is necessary because no boiling occurs at supercritical pressure and there is insufficient density differential for natural circulation.

Major difficulties were encountered during start up because start-up transients had not been fully anticipated, but these have been corrected. Breed, like Avon, is having trouble with copper deposition, although at Breed it occurs in the steam generator and appears to reach an equilibrium.

Supporting papers (bound with APC No. 24) cover: **Steam Generators, Turbine Generators, Thermal Cycle Equipment and Performance, Instrumentation and Controls, Chemical Control and Cycle Cleanup, Piping Systems, Plant Electrical Features, Switching and Transmission, and Civil Engineering Work, Coal Handling, and Supply.**

Fuels

How Coal Properties Relate to Corrosion of High-Temperature Boiler Surfaces.. APC No. 37... By J. T. Reese and James Jonakin, Mem. ASME, Combustion Engineering, Inc., Chattanooga, Tenn.; and J. G. Koopman, Mem. ASME, Electric Energy, Inc., Joppa, Ill.

It is significant that the content of compounds thought to be responsible for corrosion is considerably greater in tube and probe deposits than in the coal ash or flyash from which they originate. Tests were made on five different coals with corrosion probes and it was concluded that water-soluble alkalies and their molar ratio are the only coal properties which appear to be critical factors in deposit-type corrosion. Initial formation of deposits is due to selective deposition of low-melting products of combustion. Sulfur dioxide is adsorbed from the gas stream by iron oxide to form sulfur tri-

oxide, which reacts with alkalies and iron oxide to form complex sulfates. These, in a molten state, react with iron of the tube to cause wastage.

Effect of Pulverizer Design on Furnace Performance..APC No. 39... By H. M. Rayner, Mem. ASME, Western Electric Company, Chicago, Ill.; and P. F. Seibold, Mem. ASME, Riley Stoker Corporation, Worcester, Mass.

Since the cost of grinding coal increases with the fineness, extensive testing was undertaken to determine the minimum coal fineness that a boiler equipped with a Turbo Furnace could burn without a reduction in efficiency. The attrition section and rejector arms were removed from the Model 350 Riley Atrita Pulverizer. After several months the rejector arms were reinstalled to avoid many variables and insure uniform size consistent with the values established during the tests, and with no increase in power consumption.

It was found that the size consist of coal can be reduced to 50 per cent through 200 mesh with no decrease in boiler efficiency. Pulverizing power consumption is reduced 29 per cent, maintenance 75 per cent, and stack dust loading 24 per cent.

Liberation of Pyrite From Steam Coals.. APC No. 38... By R. A. Glenn and R. D. Harris, Bituminous Coal Research, Inc., Columbus, Ohio.

Sulfur occurs in coal in three principal forms: (*a*) Organic sulfur, (*b*) sulfate sulfur, (*c*) pyritic sulfur, which exists as discrete particles varying in size from seam to seam and mine to mine.

This research on reducing the sulfur content of coal below levels now attainable indicates that removal of the major portion of the pyritic sulfur may be accomplished by controlled pulverization to sizes coarser than those now obtained. Microscopic pyrite particles embedded in the organic matter of the coal tend to concentrate in fractions below minus 200 mesh, whereas those associated with mineral matter tend to concentrate in the greater-than-60-mesh fraction. There are good prospects for the practical removal of pyritic sulfur associated with mineral matter.

Atmospheric Pollution

Observations and Experiences Resulting From a Precipitator Improvement Program..APC No. 101... By M. J. Archbold, Mem. ASME, Commonwealth Edison Company, Chicago, Ill.

Edison-system precipitator data, experience with gas-distribution and turning vanes, prevention of corrosion by thermal insulation, relation of SO_3 and the precipitator, gas sneakage, access to the precipitator interior, and automatic voltage control are the items covered in this review. Much of the material presented at the Pennsylvania State University Electrical Precipitation Seminars in 1956 and 1957, and subsequently published in *Combustion*, is included. Ideas and opinions presented then are expanded or altered in accordance with later experience.

Power Plant Auxiliaries

Philadelphia Electric Company Multistage Flash Evaporator..APC No. 67... By M. Liss, E. F. Stalcup, and D. Cane, Assoc. Mem. ASME, Westinghouse Steam Division, Lester, Pa.; C. Caprara and W. B. Willsey, Mems. ASME, Philadelphia Electric Company, Philadelphia, Pa.

Flash evaporators have been successfully operated for the production of potable water from salt water, particularly at Kuwait on the Persian Gulf. They can also be used to provide high-purity water for electric generating stations. Single-stage units can be incorporated into the regenerative steam cycle to produce boiler make-up. Multistage units can be retrofitted to nonbase-load plants or industrial plants that require large amounts of high-purity water.

The basic principles, design features and parameters, and performance data are described for this system, which is independent of station loading, at the nonbase-load Richmond Station of Philadelphia Electric Company. Installed and operated more economically than other alternatives, it has shown comparative ease of operation and has met its production requirements.

Corrosion and Vibration in Mechanical-Drive Steam Turbines..APC No. 68... By S. Neal, Mem. ASME, and W. J. Caruso, Assoc. Mem. ASME, General Electric Company, Fitchburg, Mass.

Several corrosion and vibration problems have been selected to demonstrate that they can either be avoided or analyzed and solved by the same procedures used in other fields. A concurrent three-level attack was used by the authors. The first was qualitative—devoted to understanding the phenomenon and defining the direction of attack. Example—determining the corrosive agent, its concentration, and the reduction in strength of a material in relation to length of exposure. The second was analytic, leading, for example, to new designs with lower vibration amplitudes. The third was experimental, to permit the conversion of relative calculations to absolute values.

There are details on the reduction of erosion and wheel and rotor vibration.

Development and Operation of Fluid Drives for Turbine-Generator-Driven Boiler Feed Pumps..APC No. 70... By Richard D. O'Neil, American Radiator & Standard Sanitary Corporation, Dearborn, Mich.

In January there were seven turbine-generators—most of them with more than 12,000-hp maximum drive—in commercial operation with main-shaft hydraulic-coupling-driven boiler feed pumps. These had accumulated a total of 33,000 hr of operation without being the cause of a single unscheduled outage. Although it has been in use only six years, the idea of using the turbine-generator as the prime mover for the boiler feed pump through a fluid drive is increasingly accepted.

There is great flexibility in the use of shaft-driven pumps regardless of the design of the turbine-generator, size of the pumps, and other factors.

Second Progress Report on High-Speed Boiler Feed Pumps..APC No. 69... By Igor J. Karassik and Elliott F. Wright, Mems. ASME, Worthington Corporation, Harrison, N. J.

There are now 89 Worthington high-speed boiler feed pumps in service, being installed, or in production. These range from 5900 to 9000 rpm with discharge pressures of 2125 to 4803 psig and most of them are electric-motor driven through step-up gears.

The authors state that, actually, "high-head per stage pumps" might have been a more accurate term.

The head per stage may be 1500 to 2000 ft so that a four-stage pump can serve where an eight, nine, or even 12-stage pump was formerly required. Similarly, impeller peripheral velocities rise from the conventional 200 to 250 fps to a range of 320 to 380 fps. Still higher heads per stage and the possibility of higher-frequency electric-current supply are foreseen.

This second progress report—the first was given in 1957—contains a critical evaluation of the gains achieved by the high-speed concept. Since a 3600-rpm pump would not give satisfactory results above certain pressure limits, the success of the supercritical-pressure power plant is in large measure bound with this progress in boiler-feed-pump design. None of the operational difficulties with the pumps, which were described in considerable detail, can be attributed to the concept of higher operating speeds or of higher stage pressures.

NOTE: Copies of individual papers presented at the 1961 American Power Conference will be available, until the supply is exhausted, from R. A. Budenholzer, Illinois Institute of Technology, Chicago 16, Ill.

Includes Letters from Readers on Miscellaneous Subjects

COMMENTS ON PAPERS

Russia—A New Lathe Every Fifteen Minutes

Comment by A. E. Snyder[1]

SINCE reading this paper[2] I have been haunted and disturbed by what the author has said or rather more by what he has not said and left to implication. There is no doubt, however, that by means of this paper he has entered into what has become a national fad and a popular pastime, the game of "How do we stack up with the Russians?"

In this article, he makes three basic assumptions in presenting his thesis: (1) That Soviet mass-produced tools are and always will be the "cheapest"; (2) he implies that underdeveloped areas of the world require only a tool with the lowest initial cost; and (3) he implies that the status quo of either the communist or the western economies relative to the economies of the underdeveloped areas will hold for an indefinite period of time.

Going one step further, the author also diagnoses the ailments of the western world machine-tool industry as the fact that this industry is composed of a great many and diverse managements and that our western world markets are so unstable as to encourage inefficient production.

In making such far-reaching generalizations about such a major segment of your economy, one has to be careful in his generalizations, and I would like, therefore, to discuss in some detail these generalizations that the author has made.

Tools. Mass-produced tools are not always or necessarily the best tools, nor the cheapest from an over-all point of view of the user. It is, of course, always possible to produce tools with high rates of production, but is this what is needed? No, what is really needed are tools that perform reliably and efficiently and produce products with a minimum unit cost.

Tools for Underdeveloped Areas. It is safe to say that the underdeveloped countries will, during the initial phases of their industrial revolution, require large numbers of relatively simple tools which lend themselves to mass production. It also is doubtful whether the underdeveloped economies could absorb at this time any degree of sophisticated machine tools. Consequently, what is required in the underdeveloped area, at the moment, is a tool which is not needed in great numbers in our own economy and which represents a phase of industrial economy that we already have passed through.

Economies. The rate of advancement of the underdeveloped economies of the world can be equally as rapid as the Russian economy's economic advance and this will come to pass sooner than most of us imagine. It is questionable, therefore, whether a huge American short-term capital investment for producing low cost, mass-produced tools is a justifiable investment.

Furthermore, the author's diagnostics are in error if we believe in superiority of our own system over the communists. It is not by our American reasoning a shortcoming to have our industry composed of a great many and diverse forms of management for this is, in essence, the true value of our free enterprise system. This is a system based on competition of human effort and we, in America, have always believed this to be a superior way compared to a controlled economy. Instability of markets compared with the relative stability of a controlled economy or an oligopolistic form of capitalism is also not a valid criterion for comparison. The American way has always been that the choice or selection of product falls within the realm of the purchaser and that although such freedom inherently generates a fluctuation in markets as tastes change, technological obsolescence occurs, or economic factors vary, it is desirable to a loss of freedom.

A strong and growing American industry can and will play the part of a friend to the underdeveloped nations of the world, and a stagnating American industry will do nothing but frustrate and antagonize our friends, breeding even greater troubles. American industry will not pass up opportunities in world markets, but these opportunities for new business must withstand the same criteria for business investment which apply to our other markets. Namely, can we provide a desirable product to our customers at a profit to ourselves? Obviously, the American or western machine-tool industry is not going to compete against the Russian economy, if it is not profitable to do so!

American industry has undergone and is about to undergo further a dynamic period of growth due to a new element. That element is a new understanding by western businessmen of the importance of regular and systematic investment in the discovery and development of new ideas and new things. This principle and practice of making regular provision for invention are the discovery by business of the process of discovery. It represents a new revolution which is simply an extension of the capitalistic growth process. It is by this means that our economy will compete in the international marketplace.

There is about to come forth on the scene an entirely new revolution in machine tools due to large investments in research and development. For example, it is a fairly safe prediction to prophesy that, by the year 1965, approximately 50 per cent of all of the machine tools purchased will be numerically controlled. A numerically controlled machine tool now means that a single part will or can be completely finished on one machine with automated control for small lot production. These new machines will be complete integrated systems and will drill, mill, bore, tap, grind, and turn, all in a single machine.

This kind of dynamic new product development of our economy will prove its

[1] Director of research, Pratt & Whitney Company, Inc., West Hartford, Conn. Assoc. Mem. ASME.

[2] Seymour Melman, "Russia—A New Lathe Every 15 Minutes," MECHANICAL ENGINEERING, vol. 82, October, 1960, pp. 42–45.

virtue over the type of growth of a controlled economy and does not ever need to stand in the shadow of the Russian system, nor do we need to turn back the clock to a phase in our own economic growth which we already have passed through to enter into an unprofitable business venture.

Author's Closure

Even if the Soviet Union did not exist, the Western world would be faced with serious problems from low productivity and high costs and prices in machinery production. When the prices of new machines are so high as to discourage the replacement of old equipment, then old, less efficient equipment is retained. In the crucial metalworking field, about two thirds of U. S. machines are ten years old or more. This aging population of industrial machinery and the automatic restraint that it imposes on productivity in all of metalworking is one price that the whole society is paying for inefficiency in machinery production.

To be sure, the failure to use modern production-engineering technology in most of the machinery-producing industries is not an arbitrary preference of management. They cannot justify economically the operation of stable production systems when their own markets are unstable. For the same reasons, industrial research has lagged badly, and hardly a beginning has been made to explore the possibilities of standardization and modular construction. In order to stabilize the market and introduce high productivity methods into the machine tool and allied industries it will be essential to regroup operations on a large scale. When 20 firms offer a given product and each sells about ten in one year, then the result is costly duplication of blueprints, tools, and facilities. Industrial research cannot be justified, and prices are high. 250 firms may be uneconomic in this industry, but 50 firms would be a major improvement for production efficiency while insuring diversity of approach.

Stable production systems must be introduced into machine tools and allied industries in order to make possible the production of quality products at low price. By this means alone will we be able to encourage modernization of U. S. manufacturing equipment and a firm position in the international market. I recommend that, as a major public service, ASME should sponsor an inquiry to consider ways of solving these problems.

The international position has major political overtones, for whoever supplies the basic means of production thereby holds a preferred political position. Right now India can buy machine tools from the Soviet Union at one half or less of U. S. prices.

An argument that is used to justify the status quo in machinery production is that the inefficiency of small firms with unstable markets is the inescapable price of freedom in society. This is dangerous nonsense; dangerous because by associating freedom with inefficiency the rest of the world is invited to prefer autocratic regimes if rapid economic development is desired. This is also erroneous as economic theory. The fact is that large organizations using technical planning methods can be far more efficient in many fields than pocket-sized firms. We have a way of preserving personal and political freedom even with large firms. This is done by exercising the right of free association throughout society, and especially in economic life. The presence of trade unions, for example, means that even the largest management cannot convert its position into unilateral political power.

Modern production engineering is competent to produce machine tools both simple and complex on a mass-production basis. Investigation into the possibilities of constructing machines from large proportions of standardized components and modular sections will show the way to use common parts for both simple and complex units. Thus there is no contradiction between the requirements for tooling up countries for early industrialization, and for meeting the high productivity requirements of U. S. industry.

If American machine tools were produced and sold at 50 per cent lower price, the result would surely be the opening of mass markets in this country for replacement alone. With two million metalworking machines in use, replacement at a ten-year average age would mean a replacement market of 200,000 machines per year. In 1959, machine tool production was 65,000 in the United States, 75,000 in China, 120,000 in West Germany, and 160,000 in the Soviet Union.

In October, 1959, in my *Report on Productivity of Operations in the Machine Tool Industry in Western Europe* (European Productivity Agency, Paris), I wrote that: "The main recommendations of the present report (for mass production of machine tools) . . . are being implemented in the machine-tool industry of the USSR." The Soviets are doing no more than applying in their industry the mass-production technology that has been largely withheld from the machinery-producing industries of the United States.

Seymour Melman.[3]

[3] Associate professor, Department of Industrial Engineering, Columbia University, New York, N. Y. Assoc. Mem. ASME.

BOOKS RECEIVED IN LIBRARY

Fuel Cells; Power for the Future

By David R. Adams and others. 1960, Fuel Cell Research Associates, Cambridge, Mass. 160 p., 8½ × 11 in., paper. $18.75. This is a technical and economic analysis of developments and opportunities in electrochemical fuel cells. Five engineering and four liberal arts graduates formed the research group which prepared this report at the Harvard University Graduate School of Business Administration. The report is composed of a description of the fuel cell, its electrochemical processes, limitations, advantages, and criteria for evaluation; examination of conventional fuels, reserves, and consumption rates; and performance and economic analysis of present and expected fuel cells, with their use in mechanical and electrical power applications.

Introduction to the Gas Turbine

By D. G. Shepherd. Second Edition, 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 300 p., 6 × 9¾ in., bound. $7.75. Completely rewritten, this edition emphasizes principles rather than practical details, and requires knowledge of elementary thermodynamics and fluid flow. Cycle analysis is dealt with more fully than before, for both ideal and actual cycles. Four chapters are given to general and particular examination of turbines and to centrifugal and axial-flow compressors. The next three chapters deal with combustion; heat exchange; and performance and control. The final chapter surveys applications.

Jahnke-Emde-Lösch Tables of Higher Functions

Edited by Friedrich Lösch. Sixth Edition, 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 318 p., 7½ × 10 in., bound. $14. This thorough revision retains the approved features of the widely accepted Jahnke-Emde "Funktionentafeln mit Formeln und Kurven," concentrating on enlargement and facilitation of usage in the changes made. It continues the practice of dual presentation in German and English of text passages and table titles and notation. The revision has been accomplished by Professor Lösch of Stuttgart Technical College, and continues the title which first appeared in the 4th Edition, 1945.

Lectures on Theoretical Rheology

By Markus Reiner. 1960, Interscience Publishers, Inc., New York, N. Y. 158 p., 6 × 8½ in., bound. $4.85. This outline of the

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field of the deformation and flow of materials is the third edition of a series of 15 lectures delivered in various Israeli universities. In its present stage it covers rheology from "rocks to air," including such topics as rheological kinematics, dynamics, similarity and models, volume viscosity, second-order effects in elasticity and hydrodynamics, macro and microrheology, creep, damping of oscillations, and a dynamical theory of strength.

Leichtbau

By Heinrich Hertel. 1960, Springer-Verlag, Berlin, Germany. 526 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 67.50. A comprehensive study on airplanes and other light structures, designed to serve as a text for engineering students or as a manual for practicing engineers and technicians. Detailed treatment is provided of the structural materials, buckling, thin-walled structural parts, stiffened plates, etc., with particular emphasis on the optimum condition of the parts and of their connections. Forming and adhesive techniques are discussed with examples of riveted, bolted, and welded joints and of sandwich constructions. Due consideration also is given to specific problems of operational strength.

McGraw-Hill Encyclopedia of Science and Technology

Edited by William H. Crouse and others. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 15 volumes, $7^1/_2 \times 10^1/_4$ in., bound. $175. The more than six million words, and approximately 10,000 illustrations, drawings, charts, tables, etc., in this unique set of 15 volumes are grouped under some 7200 subject headings of moderate scope to bring together closely related subject matter. Numerous cross references refer to other related sections. A detailed subject index of more than 100,000 entries occupies 434 pages of volume 15, which also identifies members of the Editorial Advisory Board, the 63 consulting editors, and the 2100 contributors who wrote material in the set.

All fields of science and technology are covered on a level generally suitable for undergraduate college students, and for the serious-minded layman and some high-school students especially interested in science and technology. It is not likely to appreciably help any engineer or scientist in his own special field, but it should often be useful to him as a ready reference source of information in other fields with which he is less familiar. All sciences—life, physical, and earth—are covered, as are major applications in technology and engineering in the basic fields such as chemical, civil, electrical, mechanical, metallurgical, mining, and petroleum, and their various branches.

Materials in Nuclear Applications

Published 1960 as ASTM Special Technical Publication 276 by the American Society for Testing Materials, Philadelphia, Pa. 344 p., $6 \times 9^1/_4$ in., bound. $8.25. This volume contains papers presented at four symposiums held during the Third Pacific Area National Meeting of ASTM in San Francisco, October, 1959, and a literature survey of the title subject—"Radiation Effects in Steels." The symposiums fields are: Radiation effects and dosimetry (14 papers); postirradiation effects in polymers (5 papers); technical developments in the handling and utilization of water and industrial waste water; industrial water for reactor use (2 papers); ceramics in nuclear energy (6 papers).

Nutzenergie aus Atomkernen, Vol. 2

By Karl Rudolf Schmidt. 1960, Walter de Gruyter & Co., Berlin, Germany. 1336 p., $7 \times 9^1/_2$ in., bound. No price given. This second volume on the application of nuclear energy discusses radiation hazards and reactor shielding; reviews the problems of reactor operation and control; and includes chapters on reactor installation, raw materials, and economic and legal aspects. A list of both finished and planned reactors is appended with a historical survey of the field and an extensive bibliography.

Organizational Systems and Engineering Groups

By Louis B. Barnes. 1960, Harvard Business School, Division of Research, Soldiers' Field, Boston, Mass. 190 p., $5^1/_2 \times 8^1/_4$ in., bound. $3.50. The research here reported consisted of identifying and describing the organizational systems of each of two technical groups and of their individual parent companies, and then exploring and comparing the relationship between each system and the background, behavior, performance, and satisfaction of each group's members. As well as reporting the findings of his research, the author indicates implications the study may have for business administration and research in the behavioral sciences.

Plasma Acceleration

Edited by Sidney W. Kash. 1960, Stanford University Press, Stanford, Calif. 117 p., $6^1/_4 \times 9^1/_4$ in., bound. $4.25. This volume contains the nine papers presented at the Fourth Symposium on Magnetohydrodynamics sponsored by the Missiles and Space Division of the Lockheed Aircraft Corp. The emphasis is on the acceleration of plasma for space propulsion. The steady-state acceleration of plasma by crossed electric and magnetic fields, pulsed plasma accelerators utilizing energy from high-energy capacitor discharge, and the acceleration of ionized material by purely electrostatic means are considered.

Power to Produce

Published 1960 by the U.S. Department of Agriculture, Washington, D. C. 480 p., $6 \times 9^1/_2$ in., bound. $2.25. The Yearbook of Agriculture for 1960 examines many aspects of power as it relates to agricultural applications, but does not cover all agricultural technologies specifically. The papers submitted by 90 contributors from business, government, and the universities consider the history, potentialities, and physical effects of power in the following topical sections: Power in the past; power in the present; power on the land; power in the harvest; power and livestock; power in the market; power and efficiency; power and its economic effects; and power in the future.

Principles of Control Systems Engineering

By Vincent Del Toro and Sydney R. Parker. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 686 p., $6^1/_4 \times 9^1/_4$ in., bound. $14.50. A treatment of feedback control systems at the senior-graduate level. The order of presentation reflects the historical development of each phase. The book covers the mathematical background, including classical and Laplace-transform solution of linear differential equations, and time-domain, frequency-domain, root locus, and computer methods. The final chapter discusses the most significant recent advance, self-adaptive control systems.

The Principles of Scientific Research

By Paul Freedman. 1960, Pergamon Press, Inc., New York, N. Y. 228 p., $5^1/_2 \times 8^3/_4$ in., bound. $3.50. This book is addressed primarily to the young scientist, and discusses what research is like as an activity for those who spend their lives carrying it out. Part 1 covers the development of the process of research, and its relationship with social change and available techniques. Part 2 describes the principles of research process, and Part 3 surveys the support available for research. This new edition contains modifications to the First Edition's Part 1, concerning biological topics, and an appendix to Part 3 presenting up-to-date information.

Reactors Between Complex Nuclei

Edited by Alexander Zucker and others. 1960, John Wiley & Sons, Inc. New York, N. Y. 319 p., $8^3/_4 \times 11^1/_4$ in., bound. No price given. A compendium of recent advances in the field of heavy-ion nuclear physics is formed by these 40 papers, the Proceedings of the Second Conference on Reactions Between Complex Nuclei held in Tennessee in May, 1960, and cosponsored by the American Physical Society and the Oak Ridge National Laboratory. The five topical divisions of the Proceedings deal with transfer reactions; Coulomb excitation; scattering; transuranium, fission, and low energy Li reactions; compound nucleus reactions.

The Scientist in American Industry

By Simon Marcson. 1960, Industrial Relations Section, Princeton University, Princeton, N. J. 158 p., $5^1/_2 \times 8^1/_2$ in., paper. $3. Based on two years' study of a large industrial research laboratory, this report describes and analyzes the problems encountered by the scientist employed therein. Its central theme is the need of entirely new principles of laboratory management oriented toward the "colleague authority" of the academic community rather than the "executive authority" characteristic of industrial enterprise. There are to be other studies or organizational environments as they affect scientific personnel.

Self-Organizing Systems

Edited by Marshall C. Yovits and Scott Cameron. 1960, Pergamon Press, Inc., New York, N. Y. 322 p., $5^3/_4 \times 8^3/_4$ in., bound. $8.50. The 14 papers and associated discussions here presented represent the Proceedings of the Interdisciplinary Conference on Self-Organizing Systems of May, 1959, cosponsored by the Office of Naval Research and the Armour Foundation, which investigated the field of cognitive systems for the solution of nonnumerical information processing problems. Authors and conferees represent scientific, engineering, and social-scientific disciplines. The papers are published as presented, and fall into four interdisciplinary groups: perception of the environment; effects of environmental feedback; learning in finite automata; structure of self-organizing systems.

Space Research

Edited by Hilde Kallmann Bijl. 1960, Interscience Publishers, Inc., New York, N. Y. 1195 p., 7 × 9¾ in., bound. $24. This volume contains the Proceedings of the First International Space Science Symposium, held in Nice, January, 1960, and sponsored by the Committee on Space Research of the International Council of Scientific Unions. Included are nearly 100 papers contributed by scientists from 18 nations, arranged in seven topical sections, as follows: The earth's atmosphere; the ionosphere; tracking and telemetering; solar radiation; cosmic radiation; interplanetary dust; the moon and the planets.

Statistical Theory and Methodology in Science and Engineering

By K. A. Brownlee. 1960, John Wiley & Sons, Inc., New York, N. Y. 570 p., 6 × 9¼ in., bound. $16.75. An elementary text involving simple college algebra and little calculus, with the balance between theory and practice weighed toward the understanding of principles. Topic selection for inclusion was made on the basis of the "interesting and useful," and length limitations imposed by the number of course hours available. Among those selected are binomial, multinomial, hypergeometric, Poisson, and bivarite normal distributons; variance analysis and tests; nonparametric tests; linear regression; hierarchical situations; and design of experiments.

The Story of Engineering

By James Kip Finch. 1960, Doubleday & Company, Inc., Garden City, N. Y. 4½ × 7 in., paper. $1.45. An outstanding writer on the history of engineering presents here the history of the works of the master builders of the Western world, from the early Egyptians to the leaders of 20th century engineering. It is the account of the great construction works of man—bridges and roads, dams and canals, mines and machines—as well as the modern discoveries in such fields as electrical and chemical engineering, told in terms of individual engineers who contributed to these fields of endeavor.

Surface Microtopography

By S. Tolansky. 1960, Longmans, Green & Company, Limited, London, England. 296 p., 6 × 9 in., bound. 55s. The aim of this book is to show what can be achieved by multiple-beam interferometry when it is applied to the study of microtopographics of surfaces. It reports the work of Dr. Tolansky and student collaborators during the past 15 years at London University, describing theory, discussing techniques, summarizing the main results, and presenting 359 interferograms made in conjunction with the investigations. Except for footnotes to works by other authors, references given are to the papers and theses of the author and his students.

Symposium on Air-Pollution Control

Published 1960 as ASTM Special Technical Publication No. 281 by the American Society of Testing Materials, Philadelphia, Pa. 44 p., 6½ × 9¼ in., bound. $1.50. At the Third Pacific Area National Meeting of the ASTM in San Francisco, October, 1959, the following papers were presented and here are published: Air-pollution potential of California coastal climate; wind and weather summaries for chemical-plant design and air-pollution control; fluorescent dyes as airborne tracer materials; colorimetric determination of formaldehyde and methanol from combustion source; determination of gaseous and particulate inorganic fluorides in the atmosphere.

Theorie der Schüttgutbewegung

By Rudolf Kvapil. 1959, VEB Verlag Technik, Berlin, Germany. 83 p., 6 × 8¼ in., bound. DM 9.00. Based on a series of laboratory experiments in Czechoslovakia, this small book discusses the laws of motion of both fine and coarse bulk material in bunkers and silos. The observations include symmetric and asymmetric bunkers; bunkers with one and with several borrow areas; split bunkers; silos and grain elevators. The study aims to show that this basic experimental work has finally led to definitions and conclusions which will allow satisfactory bunker construction in the future. The appendix includes a list of German and English references.

Theory and Application of Ferrites

By Ronald F. Soohoo. 1960, Prentice-Hall, Englewood Cliffs, N. J. 280 p., 6¼ × 9½ in., bound. $9. An introductory study of ferrites at and below microwave frequencies. Part 1 develops the theory underlying the behavior of ferrites, and part 2 covers in some detail the applications of ferrites.

The Theory of Brillouin Zones and Electronic States in Crystals

By H. Jones. 1960, Interscience Publishers, Inc., New York, N. Y. 268 p., 6½ × 9 in., bound. $9.50. An account of the "band theory"—the mathematics of the solution of the Schrödinger equation in which the potential energy has the symmetry properties of one or other of the crystallographic space groups. The seven chapters deal with the one-dimensional periodical potential, Brillouin zones, the classification of electronic states and descriptions of point groups and special space groups, large zones in extended *k*-space, quantitative estimates of wave functions and energies, and spin-orbit coupling effects.

Transport Phenomena

By R. Byron Bird and others. 1960, John Wiley & Sons, Inc., New York, N. Y. 780 p., 6¼ × 9¼ in., bound. $13.75. An introduction to the field of transport phenomena for students of engineering and applied science. It is a parallel, systematic treatment of the three transport processes: momentum transport, or viscous flow; energy transport, or heat conduction, convection, and radiation; and mass transport, or diffusion. The media in which transport phenomena are occurring are regarded as continua, and little is said about the molecular explanation of these processes, the continuum approach being considered by the authors as of more immediate interest to engineering students.

VDI-Steam Tables

Edited by Ernst Schmidt. Fifth Edition. 1960, Springer-Verlag, Berlin, Germany. 119 p., 8 × 11½ in., bound. No price given. In this new edition the temperature range remains the same but the pressure range has been extended to 500 atm. The three sections of the tables are as follows: State of saturation (temperature table); state of saturation (pressure table); values of volume, enthalpy and entropy for water and superheated steam. The large folded Mollier diagram is in a pocket at the back. The foreword and the explanatory introduction are given in three languages —German, English, and French.

Werkstoffkunde der Hochvakuumtechnik, Vol. 1: Metalle und Metallisch Leitende Werkstoffe

By Werner Espe. 1959, VEB Deutscher Verlag der Wissenschaften, Berlin, Germany. 916 p., 7 × 9½ in., bound. No price given. This first volume of a three-volume set dealing with materials used in high-vacuum technology covers the metallic materials. It is a comprehensive and detailed reference work on the properties and applications of the metals and alloys of importance in the field including the rare metals such as thorium, gallium, etc. The final section treats special processes such as metal volatilization, the joining of metals for vacuum work, and the treatment of metal surfaces. Each chapter is treated as a separate monograph with its own list of references.

Work Sampling for Modern Management

By Bertrand L. Hansen. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 263 p., 6¼ × 9¼ in., bound. $7.50. This is a step-by-step explanation of how to make a profitable fact-finding sampling study from the initial planning stage to the last step of the follow-up. Part 1 is for those who wish to learn how to make a work-sampling study. Part 2 is for those who wish to study more extensively the principles and theory which make sampling a valid and reliable technique.

American Power Conference, Proceedings, 1960

Published 1960, Illinois Institute of Technology, Chicago, Ill. 869 p., 6¼ × 9¼ in., bound. $10. The annual American Power Conference is concerned with practice rather than theory, and a broad over-all view of problems of interest to the power industry and associated groups. Six topical sessions were held at the 1960 meeting. Papers presented at the general sessions deal with national considerations such as American economic power, national strategy, nuclear propulsion in the Navy, and the challenge of new power sources such as magnetohydrodynamic generation, isotopic heat and power, and space-vehicle propulsion. Nuclear power plants are discussed in the nuclear power sessions papers; steam generators and turbines, peaking and central station power plants and auxiliaries, condensers, fuels, industrial plants, traction-vehicle power and space heating in the mechanical sessions papers; turbine-generators, high-voltage systems, switching, distribution, communications and protection control, computers and network analyzers, and system planning and operation in the electrical sessions papers. The final two sessions dealt with hydroelectric power-rates, revenues, and new project financing and water technology—analysis and pollution control in industrial water, and sea-water conversion.

Berechnung und Gestaltung von Metallfedern

By Siegfried Gross. Third Edition. 1960, Springer-Verlag, Berlin, Germany. 156 p., 6¼ × 9¼ in., bound. DM 21.00. A concise mathematical treatment of the calculation and design of a number of spring types: Leaf springs, disk springs, cylindrical, and conical coil springs.

Cost Engineering in the Process Industries

Edited by Cecil H. Chilton and others. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 475 p., 9 × 11¼ in., bound. $11. This is a compilation of those articles still relevant from the series published by *Chemical Engineering* magazine from 1947 through December, 1959, dealing with cost estimation and engineering economics in the process industries. Where cost data are expressed in dollars, an appropriate date or index level is included so that the data may be corrected for current use.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

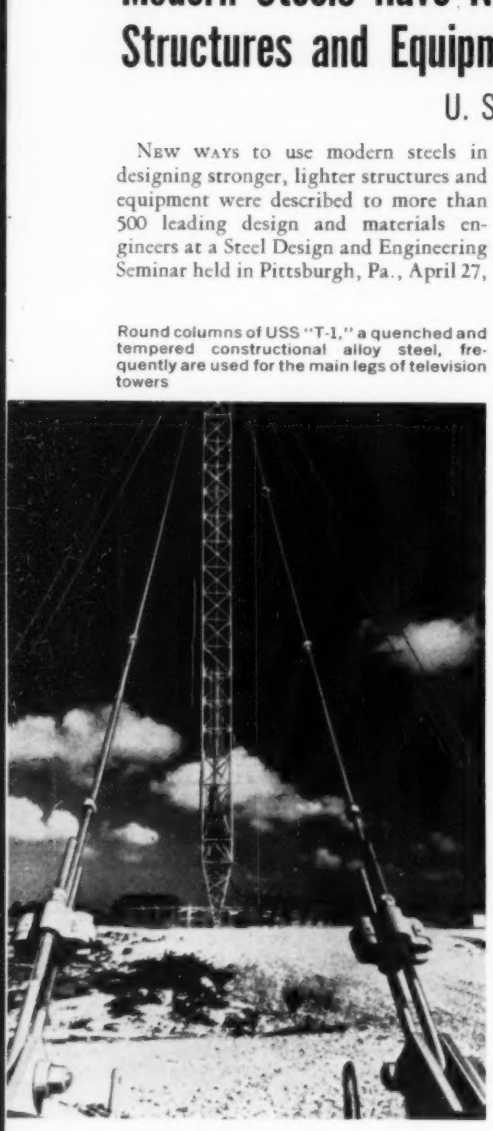
THE ROUNDUP

Modern Steels Have Numberless Uses in Structures and Equipment Design

U. S. Steel Seminar in Pittsburgh reveals new uses for today's steel

NEW WAYS to use modern steels in designing stronger, lighter structures and equipment were described to more than 500 leading design and materials engineers at a Steel Design and Engineering Seminar held in Pittsburgh, Pa., April 27, and conducted by U. S. Steel Corporation.

Round columns of USS "T-1," a quenched and tempered constructional alloy steel, frequently are used for the main legs of television towers



The visiting engineers, representing more than 20 major structural and equipment design fields, were told by U. S. Steel's Richard F. Sentner, executive vice-president-commercial, that "With a team approach—designer and materials supplier working together as they must—the frontiers of design in steel can be greatly extended.

"Your objective is always to design a salable product," Mr. Sentner noted, adding that "together we can go beyond traditional data and traditional steels and apply new reasoning, new insight, and new imagination to designs that will make your products more salable."

New Design Concepts. At the Seminar's opening session on new design concepts, U. S. Steel's Stephen M. Jenks, Mem. ASME, executive vice-president, engineering and research, introduced four technical speakers who told the overflow audience that:

1 An entire "family" of constructional steels is presently available from U. S. Steel for designing better—yet lighter and less costly—structures and equipment of all kinds.

2 Selecting the right steel or steels for the most efficient and economical structural design involves a "fourth dimension" which the designer must consider at the same time he considers design geometry.

3 New research findings now permit accurate prediction of the strength of columns made from various constructional steels and by different fabrication techniques.

4 Many new product forms and new types of constructional steels have recently been developed or are now under development by U. S. Steel to meet the challenges of rapid technological change in all phases of science and industry.

Up Performance, Down Cost—Competition Makes It So. In introducing the four speakers, Mr. Jenks said: "With the increasingly competitive conditions that we all work under today, it is absolutely essential that we attain the maximum in performance at the minimum in cost."

He pointed out that, to achieve this goal, design engineers must become familiar with available new steels and use them advantageously in designing new, improved, or more economical structures.

"Optimum utilization of new materials by designers means they must be given complete information on qualities such as strength, formability, weldability, and corrosion resistance," he said, adding that "we have a large staff of research people and metallurgical service people who devote their entire time to the development of such information."

In presenting the first technical paper, U. S. Steel structures engineer J. A. Gilligan explained the concept of "the fourth dimension in design." "It involves the proper selection of materials from the many that are available today," he said.

"In the past," he explained, "the designer was limited to a few types of constructional materials and consequently, design was essentially a matter of geometrical considerations."

He suggested that engineers should not

make arbitrary advance decisions to use certain well-known materials and then proceed to work out design geometry based on the properties of these materials. Instead, he submitted that they should consider material selection and geometry at the same time.

"Only by proper consideration of this fourth dimension (material selection) can the designer fulfill his objective, which is to produce the most efficient, safe, and economical structures," he said.

As an example of one way to apply the fourth-dimension concept, Mr. Gilligan asked the Seminar audience to consider the design of an oil-storage tank. "Pressures on the tank walls range from zero at the top to a maximum at the bottom," he said. "If the designer chose ASTM A7 structural carbon steel for the tank walls," he explained, "the wall thickness would vary in steps from a minimum at the top to a maximum at the bottom.

"By using the fourth-dimension concept with the family of constructional steels now available," he said, "steels of different strength levels can be used to build a tank with uniform wall thickness from top to bottom."

He pointed out several advantages of this design concept: (*a*) Initial cost savings because less plate material is needed, (*b*) reduced shipping cost on plate materials, (*c*) lower welding costs because of thinner plates, (*d*) lower maintenance costs.

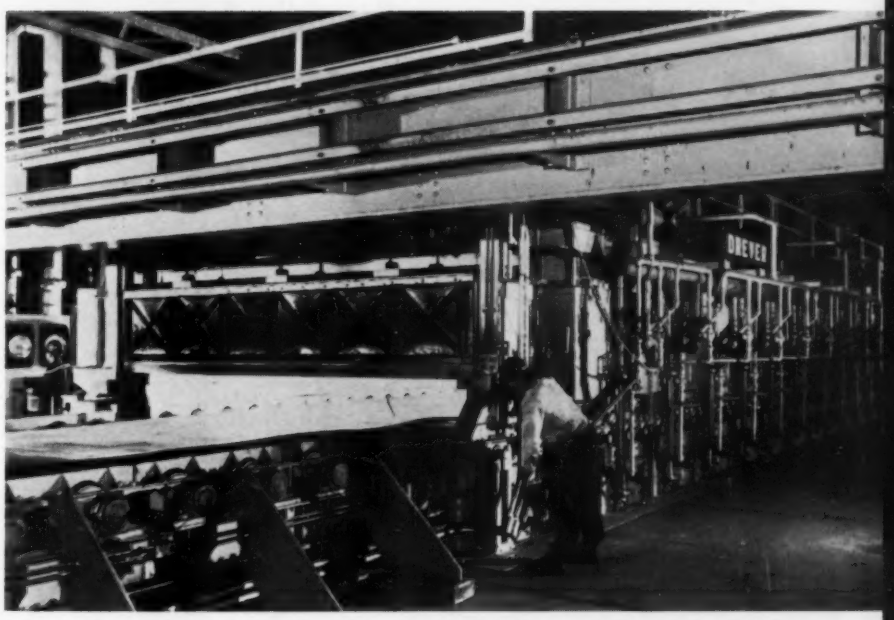
G. Haaijer, of U. S. Steel's Applied Research Laboratory, explained how structures can be built of stronger steels to achieve lighter-weight and lower-cost designs.

"In contrast with many of the higher strength steels that have been available in the past," he said, "the modern higher strength steels show more favorable price-to-strength ratios than structural carbon steel...the relative increase in price is less than the relative increase in yield stress."

So-called "hybrid" steel beams that are built up by welding higher strength steel flanges to lower strength steel webs represent one new design concept involving stronger steels, he noted.

"For example," Dr. Haaijer said, "a hybrid steel beam with an A7 steel web (33,000-psi yield point) and USS 'T-1' Type A steel flanges (100,000-psi yield strength) shows a 15 per cent material cost saving and a 37 per cent weight saving in comparison to a welded beam made entirely of A7 structural carbon steel."

A third paper, presented by L. S. Beedle, director of the Lehigh University Fritz Engineering Laboratory, discussed recent research findings that make it possible to predict the strength of centrally loaded steel columns.



Newest addition to the steel industry's most complete array of plate heat-treating equipment is a second continuous quenching and tempering line at United States Steel's Homestead District Works. Here an alloy steel plate enters the hardening furnace—first step in the process. After being heated in this furnace, the plate will be quenched by water sprays and tempered in a second furnace similar to the one shown. This new plate-treating line is almost identical to the original line installed at the Homestead plant's 160-in. plate mill. Located in the same building, the two lines share auxiliary equipment.

"A consistent explanation of column behavior can now be made for steels of different yield-stress levels which are subjected to different fabrication processes," Dr. Beedle said. "The accuracy of the predictions," he explained, "depends on appropriate use of the tangent-modulus concept and a consideration of initial out-of-straightness conditions."

In the final technical presentation of the Seminar, R. W. Simon, U. S. Steel's vice-president of metallurgy, pointed out the need for dependable, economical materials to back up new design concepts.

Producibility, Quality, and Cost. He explained that any new steel produced by U. S. Steel must meet three criteria: producibility, quality, and cost.

"A steel which looks promising in the laboratory will not be acceptable if its properties or performance depend on impracticably close control of treatment or fabrication," he said. "It will not be produced if its composition is such as to prevent the melting of sound, high quality product. And lastly, if it can be produced, it will not be bought if its price is too high."

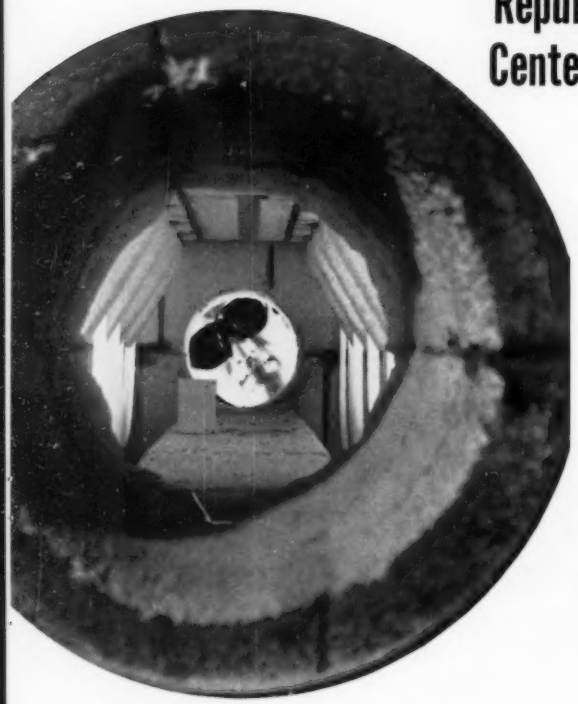
Among examples of new steels recently introduced by U. S. Steel, Mr. Simon listed: USS Ex-Ten, a high-strength low-alloy steel which offers weight reduction with exceptional economy; USS Strux, a complex alloy steel developed for the landing gears of military aircraft. It can be heat-treated to yield strengths ranging from 180,000 to 240,000 psi; USS Airsteel X-200, another complex alloy produced in the form of sheet and light plate for aircraft and missile design. A simple normalizing treatment, instead of oil or water quenching, produces a minimum yield strength of 230,000 psi and keeps distortion of large and complex parts to a minimum; and USS "T-1" Type A steel, introduced last year, which provides the same strength as USS T-1 constructional alloy steel in thicknesses through one inch, but at lower cost.

Several development projects are under way to produce new steels and steel products for structural design applications, Mr. Simon noted.

Following the technical session, Seminar visitors toured a variety of heat-treating facilities at U. S. Steel's Homestead District Works. These facilities, consisting of continuous and batch-type equipment for heat-treating alloy and stainless steels, plus additional units for heat-treating large forgings, are said to be the largest and most versatile in the world.

Seminar activities concluded with a tour of U. S. Steel's Applied Research Laboratories at Monroeville, Pa.

Republic Aviation Unveils Paul Moore Center for R&D to Aid Space-Age Research



Making Aerospace Materials. The unusual materials and components required for withstanding conditions encountered during flight into space are made in this special furnace capable of temperatures up to 3000 F. Here a technician in Republic's Materials Lab observes a ceramic specimen as it begins heat-treatment. The furnace can maintain such high temperature over a period of days. Lab is one of eight facilities that make up the company's $14-million Paul Moore R&D Center.

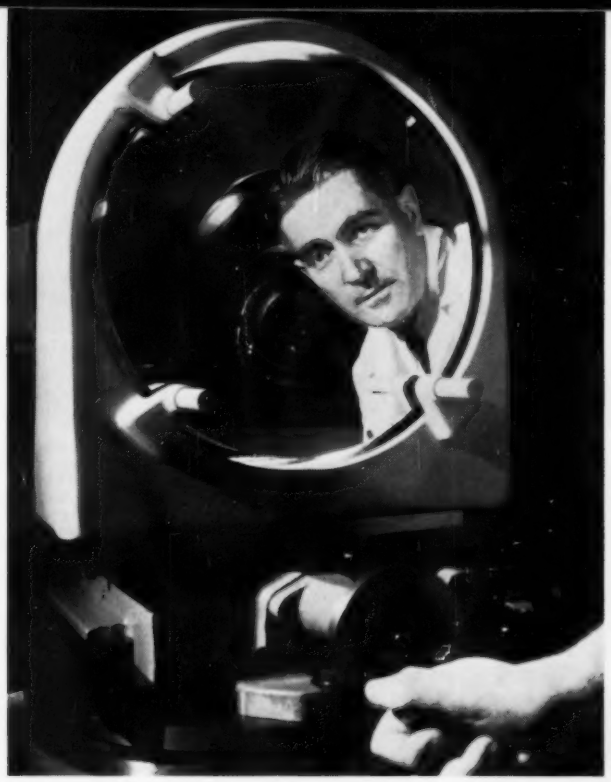
REPUBLIC Aviation Corporation held dedication ceremonies on April 29, at Farmingdale, L. I., for a $14-million home for the creation of generations of manned space vehicles.

Built around a complex of seven advanced research laboratories—Space Environment and Life Sciences; Re-entry Simulation; Materials Development; Nuclear Radiation; Guidance and Control Systems; Fluid Systems; and Electronics—and supported by a trio of wind tunnels, this three-level research and development Center already has design groups at work on plans for manned vehicles ranging from aircraft twenty times the speed of sound to lunar reconnaissance spaceships.

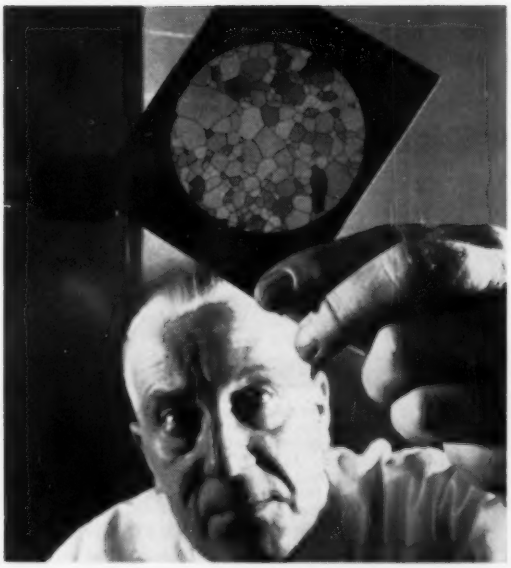
The Center, dedicated in memory of Paul Moore, one of the founders of the 30-year-old company, is believed to be the most diversified privately owned facility of its type, and it has the built-in capability of developing complete astronautical systems. Much of the equipment had to be especially built; for example, the hydrogen gun to study meteorite impact, the space-simulation chamber, and the anechoic (echo-free) chamber. All these are unique from either a design or capability point of view. The Center is the hub of a broad-scale expansion of research activity which began in 1958 and has since taken the company's scientists and engineers into more than 29 new technological areas.

The accelerated pace of technical progress has had the net effect of increasing not only industry's responsibility for new concepts and for more versatile and capable weapons, but also for feasibility and operational analyses. This requires manpower and facilities of scope and dimension surpassing any previous needs.

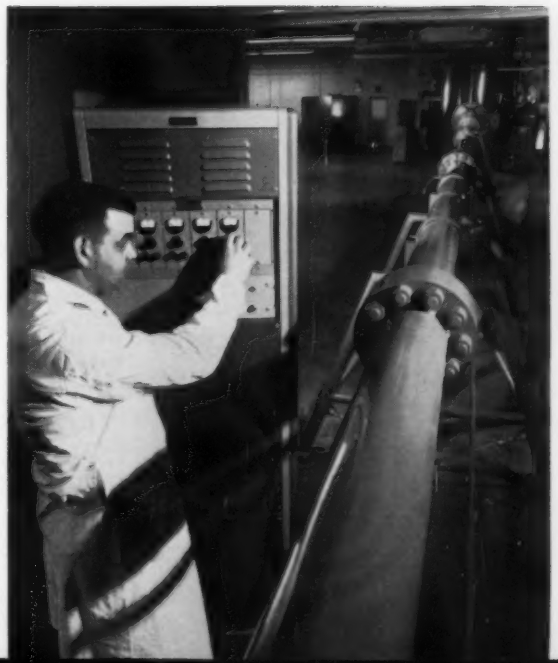
Like 150 Miles Up. Space-flight conditions more than 150 miles up can be simulated in this 30-ft-long altitude chamber, a major "tool" of Republic Space Environment and Life Sciences Lab. This is said to be the only unit of its size capable of simulating such altitudes. It tests not only man but also complete space systems and capsules.



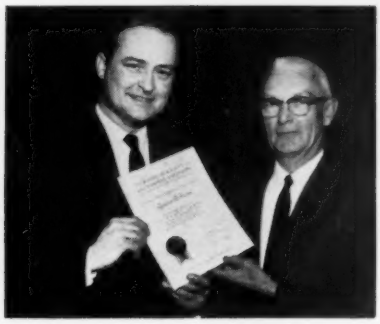
Left. Space Mirror. This 12-in. optical flat mirror is part of an advanced testing instrument known as an autocollimator. Over 15 ft long, the instrument provides a parallel beam of light 16 in. in diam for use in Republic's Guidance and Control Lab. It is used to test the functioning and accuracy of optical systems both in the visible and infrared portions of the spectrum. The tests are part of developmental work for gyro-stabilized star-tracking systems. **Below. Computers for Space.** An electronic capacitor less than a millionth of an inch thick is examined at Republic's Guidance and Control Systems Lab. Capacitor is example of the Lab's work in the field of microminiaturization of computer components for space navigation. Bulky computer logic circuits are replaced by depositing thin films of metallic or semiconducting materials on glass or ceramic strips. Process is accomplished under the giant thimblelike dome of special vacuum-coating machine. The lab is one of eight facilities that make up the new Center.



Above. Space Metals. Photographic slides such as this may not fit into a family album, but they have more than a passing interest for spacemen. Here in the Materials Lab at Republic Aviation Corporation photographs of metallurgical specimens are taken by means of a metallograph shown in the background. Prior to the click of the lens, surface of the specimen is electro-polished and chemically treated to exhibit basic microstructural details. From such studies into the properties and characteristics of metals and their compounds will come spaceship materials of tomorrow. **Right. Mach 20 "Shock" Tube.** Models of newly designed spacecraft and components are tested inside this ultrahigh-pressure (100,000 psi) combustion-driven Mach 20 shock tunnel. It is a major tool of the Re-entry Simulation Lab at Republic. Models are placed in vacuum tank at the end of 120-ft tube. Through specially designed windows scientists can observe and photograph reactions to re-entry conditions at 15,000-mph speeds.



H. B. Lindblom, **third from left,** chairman of the ASME Arizona Section, presents charter designating subsection status for Southern Arizona ASME membership to M. R. Bottaccini, chairman of the Subsection Development Committee. Looking on at **left** are A. R. Joyce director, and M. F. Veck, chairman. At **right** are H. D. Christensen, vice-chairman; Mrs. Jane Randolph, director; and Harvey T. Munn, secretary-treasurer.

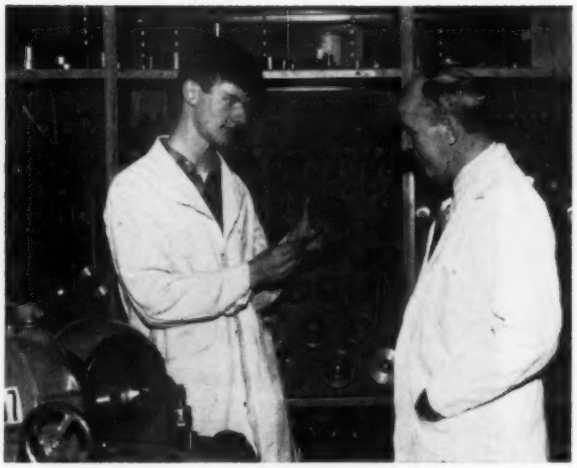


Z. R. Bliss, **right,** chairman of ASME Standardization Committee, received a certificate of appreciation upon his retirement as chairman of Sectional Committee B.4 on Allowances and Tolerances for Cylindrical Parts and Limit Gages. The presentation was made by J. P. Trowbridge, senior member of the Standardization Committee.

R. G. LeTourneau, Fellow ASME, world-renowned industrialist who recently received the International Progress Award for 1960 from the American Society of Tool and Manufacturing Engineers, looks over some drawings at his engineering firm in Longview, Texas. The ASTME award for progress in manufacturing was presented to Mr. LeTourneau at a banquet at the Statler Hilton Hotel in New York, N. Y., on May 20.

Paul O. Heyer, **center,** recipient of the Kahn Architectural Fellowship for 1960–1961, views a proposed building project in the Detroit, Mich., office of Sol King, **right,** president of Albert Kahn Associated Architects and Engineers, Inc. George H. Miehls, **left,** is chairman of the company, which established the fellowship at the University of Michigan in 1941. Mr. Heyer is a graduate of the Brighton College of Art, Brighton, England.

PEOPLE



Sven Olaf Tovborg Jensen, **left,** a mechanical-engineering student from the Technical University of Copenhagen, Denmark, discusses a heavy-duty vehicle part with Chet Kasten, chief inspector at FWD Corporation, Clintonville, Wis. Mr. Jensen, an exchange student, is studying American manufacturing techniques and processes at FWD Corporation. He is one of 6430 foreign students who are studying in the U. S. A. under the auspices of the International Association for the Exchange of Students for Technical Experience (IAESTE).

Lawrence B Webster, **center** receives an ASME 50-year membership pin from Tom C. Tang, chairman of the Trenton Subsection, at a joint meeting of the Subsection and the Princeton University ASME Student Section April 12. Looking on at **right** is Frank Alexander, chairman of the Princeton University Section. Guest speaker at the meeting, which was held in the University's School of Engineering, was Clive M. Usiskin, Assoc. Mem. ASME, of the RCA Astro-Electronics Division, whose topic was "Sources of Control Torques for Space Vehicles."

ASME's newly organized West Texas-Southern New Mexico Subsection is officially chartered as Tom Boone, **third from left,** Subsection Chairman, receives the charter from E. H. Draper, Vice-President, ASME Region VIII. Looking on at **left** are Alan Pope of Sandia Corporation, who was guest speaker at the February event in El Paso, Texas; and Art Clark, chairman of the New Mexico Section. Jack Hardgrave, secretary-treasurer of the new Subsection, is **second from right.** At **right** is Louis Bothell, Subsection director.

Scientists Tour Japan. Nine automatic-control scientists from American universities and industries toured Japanese laboratories, plants, and universities, May 9–30, at the invitation of the Japanese National Committee of Automatic Control. Chairman of the U. S. group was RUFUS OLDENBURGER, Mem. ASME, director of the Automatic Control Center at Purdue University. Among other members of the group, which included three university professors and five industrial representatives, were JOHN E. GIBSON, Assoc. Mem. ASME, professor of electrical engineering at Purdue; SY HERWALD, Mem. ASME, vice-president of Westinghouse Electric Corporation Research Laboratories; and HERBERT W. ZIEBOLZ, Mem. ASME, of the General Precision Equipment Corporation, New York, N. Y.

Honors and Awards. BURGESS H. JENNINGS, Fellow ASME, professor of mechanical engineering at Northwestern University, has received the Award of Merit from the American Society of Heating, Refrigeration and Air-Conditioning Engineers. A top national engineering award, it has previously been presented only four times, and was awarded to Prof. Jennings for outstanding service and achievement in teaching and research. Prof. Jennings took another high award in 1950 when he received the Richards Memorial Award of Pi Tau Sigma, given annually to the most outstanding American mechanical engineer.

M. D. STEPATH, president of Arc-Air Company, received the Samuel Wylie Miller National Award for contributions to the art of welding and cutting during the annual meeting of the American Welding Society held April 17 at the Hotel Commodore in New York City. Other award winners at the AWS annual meeting were: JULIUS HEUSCHKEL, consulting welding engineer at the Westinghouse research laboratories, Pittsburgh, Pa., who received the 1960 James F. Lincoln Gold Medal; G. E. CLAUSSEN, of the Arcrods Corporation, and H. E. MILLER of The Carrier Corporation, winners of the National Meritorious Service Award; and A. L. COOPER and W. H. MORSE, Assoc. Mem. ASME, Westinghouse Electric Corporation, C. A. ZWISSLER, Kaiser Steel Corporation, and M. FRIEDMANN, Friedmann Welding Company, winners of A. F. Davis Silver Medals. The Adams Memorial Membership Award for outstanding teaching activities in welding went to W. H. MUNSE, University of Illinois. This year's Adams Lecturer was HENRI P. GRANJON, of The Ecole Superieure de Soudre Autogene, Paris, France.

Campus Data. JAMES J. RYAN, Mem. ASME, was honored May 22 at a reception celebrating the completion of his 30th year on the mechanical-engineering staff of the University of Minnesota. The reception was held in the Grand Ballroom of Coffman Memorial Union on the campus. Instruments and other equipment he has invented were on exhibit in his research laboratory.

INDUSTRIAL FILMS

Radioisotopes

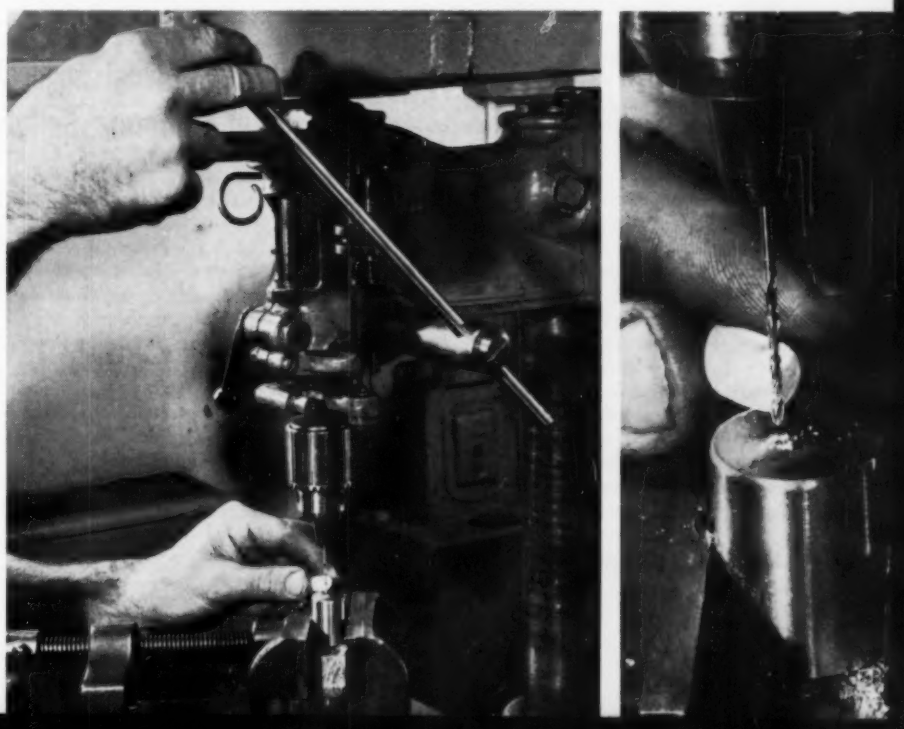
"Industrial Applications of Radioisotopes," a 16-mm, semitechnical film available from the Atomic Energy Commission, is a survey of the current widespread usage of radioisotopes in American industry. Examples of industrial uses of isotopes for thickness, density, and level gaging, radiography, and tracing were filmed at 26 sites across the nation, including such industries as rubber products, sheet metal, plastics, paper, nylon, food and container, shipbuilding, oil, and automobiles. Applications with potential for the future also are shown. The basic principles of radioisotope use are explained with the aid of animation. The 57-minute, color motion picture was produced by the U. S. Army Pictorial Center under the technical direction of the commission's Office of Isotopes Development, and is available for loan at the commission's 10 domestic film libraries, or for purchase from the Army Pictorial Center, 35-11 35th Ave., Long Island City, N. Y. Information on purchase of prints may be obtained from the Audio-Visual Branch, Office of Public Information, U. S. Atomic Energy Commission, Washington 25, D. C.

Stainless-Steel-Machining Film

"MACHINING Stainless Steels—Part II," is a new 16-mm film on procedures and "tricks of the trade" utilized in high-production stainless-steel machining operations with single and multiple spindle automatics. Released by the Armco Steel Corporation, the film is the second in a series initiated in 1956. This machining series is said to be the only one of its kind in the industry.

The 30-min film, which stresses the practical aspects of complex machining, is directed at experienced machining engineers and operators involved in planning, programming, and executing production machining operations. The information presented is applicable to stainless-steel machining operations in general and to high-production operations utilizing automatics in particular. Automatics form the backbone of the machining industry for high-production runs. The film was produced by Paul Hance Productions, Inc., New York, N. Y. It can be obtained free through The Jam Handy Organization, 2821 East Grand Boulevard, Detroit 11, Mich.

"Machining Stainless Steel," an Armco Steel Corporation film, demonstrates how chalk reduces glazing problems for small drills. Large drill presses are not sensitive enough to control the fine feeds needed at the top speeds required by small diameter drills, and the small drills have a tendency to glaze when starting or restarting a cut. Although a small precision press should be used in place of the large unit, applying chalk on the workpiece and drill point of a small drill in a large chuck will enable the drill to start cutting through the glazed surface.



Recruiting Practices and Procedures Defined in New Pamphlet

THE ASEE has published a pamphlet on recruiting practices and procedures. The ECPD Ethics Committee has endorsed the code.

The foreword of the pamphlet states that "Certain recruitment practices have developed from time to time, in the stress of competition for engineering graduates, which have not been consistent with professional standards." A brief of the 1959 revision which follows represents the combined efforts of a "task force" comprising the ASEE Committee on Ethics and the College Placement Council with the exception of Item 7 under "Employer Responsibilities." This item contains detail about conditions of employment that are most important to engineering students. The ASEE Committee on Ethics believes this particular detail is essential to the implementation of the "General Principles" expressed in the "Code."

Item 7 states "The interviewer should clearly explain to the Placement Office and students any special requirements such as the passing of tests, physical examinations, signing of patent agreements, or if his job is affected by any union contract."

The code is divided into two broad sections: (*a*) General Principles and (*b*) Practices and Procedures. Under Practices and Procedures are three subdivisions: (*a*) Responsibilities of the Employer, (*b*) Responsibilities of the College, and (*c*) Responsibilities of the Student.

The general principles establish the importance to the college and employers alike of good career selection. The procedure followed during this selection period should evidence personal responsibility and good attitudes on the part of all those involved.

Responsibilities of the Employer. He should keep the Placement Office informed and work closely with them in connection with his student contacts. Rejections or acceptances of the student by the employer should be prompt, and there should be no undue pressure such as excessive entertainment or special payments, gifts, bonuses, or other inducements. Bargaining should be avoided. Pressure should not be brought to bear on a student to have him hurry into a decision before he has the opportunity to gain complete information on those jobs which might be of interest to him.

Responsibilities of the College. The college should inform the student regarding job opportunities and procedures for getting these jobs. The Placement Office should inform the employers concerning the number of students, their education, and any other special characteristics of the students which might be available and schedule the time and place of the interviews. The Placement Office should make certain that students are acquainted with the principles and practices of college recruiting.

Responsibilities of the Student. The student should inform himself concerning forms that have to be filled out or any other special actions on his part which might be necessary. If he plans on interviewing a company he should have some acquaintance with its recruiting literature. When a student is invited to visit an employer's premises at the employer's expense, he should include on his expense report only those costs which pertain to the trip. If he visits several employers on the same trip, costs should be prorated among them.

Acceptances and rejections by the student should be made promptly once he has arrived at a decision and should not be thereafter capriciously changed. Students should keep their Placement Office advised concerning their employment negotiations in accordance with the policies of the Placement Office.

COMING MEETINGS

Atomic Age: Problems

THE atomic age has produced a wealth of entirely new problems for engineers, architects, scientists, executives, and others in management.

Consideration must now be given in the design of structures to the effects of atomic weapons, both from the standpoints of nuclear blast and radiation.

These problems have prompted The Pennsylvania State University to offer three seminars in the areas of atomic shelter and survival in the nuclear age during the coming summer.

The first of the seminars, Planning Aspects of Atomic Shelter, July 9 through July 21, is for architects and engineers who are or will become involved in planning and preliminary design aspects of buildings, shelters, and facilities to resist the effects of nuclear weapons.

From July 23 to August 4 will be the second event, Structural Engineering Aspects of Atomic Shelter, a short course for structural and architectural engineers involved in the analysis and design of structural systems and radiation shielding systems of buildings, shelters, and structures.

The third seminar, to be held August 13 to 18, is titled Survival in the Nuclear Age—Executive Management. It is intended for executives, architects, engineers, and others in management responsible for the administrative planning of industrial, governmental, municipal, hospital, and other facilities and complexes for the incorporation of protection against the effects of nuclear weapons.

Further information may be obtained from the Shelter Research and Study Program, 133 Hammond Bldg., The Pennsylvania State University, University Park, Pa.

Fourth U. S. National Applied Mechanics Congress, University of California, Berkeley, June 18–21, 1962

THE U. S. National Congresses of Applied Mechanics are held every fourth year under the auspices of the U. S. National Committee on Theoretical and Applied Mechanics, a joint committee of the American Institute of Chemical Engineers, the American Mathematical Society, the American Physical Society, the American Society of Civil Engineers, The American Society of Mechanical Engineers, the Institute of the Aerospace Sciences, and the Society for Experimental Stress Analysis. These Congresses are planned to supplement the International Congresses of Applied Mechanics but not to compete with them. Accordingly, no effort is made to attract papers from outside the U. S. and Canada, although there is no rule against their presentation.

All research workers in the field are invited to submit papers constituting original experimental or theoretical contributions to applied mechanics, including mechanics of rigid bodies and deformable solids, mechanics of fluids and gases, thermodynamics, and heat transfer. It is expected that papers accepted by the Editorial Committee, with the advice of recognized authorities and presented at

the Congress, will be published in full in the Proceedings of the Congress.

To be considered for presentation at the Congress, complete papers and manuscripts must be submitted to the Chairman of the Editorial Committee before Jan. 1, 1962; to be scheduled for presentation the final manuscript of a paper must have been accepted before May 1, 1962. To avoid delays caused by overburdening reviewers and editorial staff, authors are urged to submit manuscripts well ahead of the deadline of Jan. 1, 1962.

The papers will be grouped by subject and 30 minutes will be allotted for presentation and discussion of each paper. Arrangements also will be made for general lectures by outstanding authorities on subjects of general interest to members of the Congress. Facilities will be provided for informal discussions and social contact.

Preparation of Papers: No paper, including text, equations, tables, and figures, should exceed the equivalent of 5000 words. Manuscripts should be submitted in duplicate, but it is requested that the first page of each manuscript containing only the title of the paper, the name and affiliation of the author, and an abstract of not more than 100 words be submitted in triplicate, because it is planned to publish abstracts of accepted papers in the June, 1962, issue of the *Journal of Applied Mechanics*.

One copy should be in original typewriting (or clear mimeographing) on only one side of white paper sheets and be double spaced with margins of at least 1 in. width. Figures should be submitted in reproducible India ink drawings on separate sheets of drawing paper or cloth. The width of the lines of these drawings and the lettering should allow for the necessary reduction. Photographs should be glossy and not larger than 8 in. × 10 in.

References should be grouped together in a bibliography at the end of the manuscript, listing author, title, publication or publisher, volume, year, and page, in that order. Text references to the bibliography should be made by numbers in brackets, references to equations by numbers in parentheses.

Manuscripts should be in final form, as corrections in proof are extremely expensive; the cost of corrections in proof representing deviations from the manuscript or caused by insufficient identification of mathematical symbols in the manuscript will be charged to the authors. Authors are advised to retain carbon copies of their manuscripts as the original manuscripts will not be returned with the proofs.

The Organizing Committee: Chairman, W. W. Soroka; Secretary, W. Goldsmith; Treasurer, E. V. Laitone; Chairman, Editorial Committee, R. M. Rosenberg; and Committee on Arrangements, R. F. Steidel, Jr., and K. S. Pister.

The Editorial Committee: R. M. Rosenberg, University of California, *Chairman;* M. V. Barton, Space Technology Laboratories, Inc.; R. L. Bisplinghoff, Massachusetts Institute of Technology; S. Corrsin, The Johns Hopkins University; S. H. Crandall, Massachusetts Institute of Technology; A. C. Eringen, Purdue University; F. N. Frenkiel, David Taylor Model Basin; R. M. Haythornthwaite, University of Michigan; E. H. Lee, Brown University; J. W. Miles, University of California at Los Angeles; L. M. Milne-Thomson, University of Wisconsin; H. Poritsky, General Electric Company; and W. Prager, Brown University.

Inquiries regarding the Congress should be addressed to the Secretary of the Congress at the University of California, Applied Mechanics, Berkeley 4, Calif.

Sixth World Power Conference in Melbourne, October, 1962; Planning Under Way for U. S. Participation

THE United States National Committee of the World Power Conference has initiated planning for participation in the Sixth Plenary Meeting of the Conference to be held in Melbourne, Australia, Oct. 20–26, 1962. At its annual meeting in Washington, D. C., on Jan. 23, 1961, the United States Committee appointed a committee on papers to select authors and subjects for the technical papers to be submitted by the United States at the Melbourne Meeting.

Twenty technical papers have been allotted to the United States by the Australian National Committee, host for the 1962 Meeting. A list of the papers showing titles, authors, and a brief outline of the scope of each paper is to be furnished the Australian Committee by June 30, 1961.

The theme selected for the 1962 Plenary Meeting is "The Changing Pattern of Power." Development of this theme is expected to emphasize the changes that have taken place in all power production, transportation, and utilization techniques since the Fifth Plenary Meeting in 1956, and to include forecasts of expected future developments. The papers and discussions will be grouped as follows:

Division I provides for (*a*) discussion of energy resources based on the World Power Conference Survey of Energy Resources and the United Nations "J" series of publications, and (*b*) summaries prepared by each National Committee dealing with past and expected future developments in the exploitation and use of all primary sources of energy.

Division II provides for papers dealing with the production and amelioration of primary sources of energy.

Division III covers the transformation of primary to secondary energy and transportation of energy.

Division IV deals with the utilization of primary and secondary energy with subdivisions determined on the basis of broad classes of user.

Division V will be devoted to economic evaluation of alternative energy sources.

The World Power Conference Survey of Energy Resources, to be discussed under Division I, will be released as a new publication prior to the Melbourne Meeting. It replaces the former World Power Conference Statistical Year-Book and will be issued at six-year intervals on the occasion of each Plenary Meeting.

The United States Committee, one of 59 National Committees from all over the world making up the membership of the World Power Conference, is composed of three major groups of participating members. They are (1) the professional engineering societies, currently including the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers; (2) the industrial, utility, or similar associations, comprised of the Association of Edison Illuminating Companies, Edison Electric Institute, and the American Gas Association; and (3) the federal and state government bodies, composed of the Atomic Energy Commission, Federal Power Commission, Bureau of Mines and Bureau of Reclamation of the Department of the Interior, the U. S. Army Corps of Engineers, and the Department of Agriculture's Rural Electrification Administration.

The affairs of the United States Committee are managed by an Executive Board of nine members, comprised of three members from each of the above-named groups. Re-elected for the ensuing year at the January 23 annual meeting were the following national officers:

Francis L. Adams, chief, Bureau of Power, FPC, Chairman; and James N. Landis, past-president and Fellow ASME, Vice-President, Power Division, Bechtel Corporation, Vice-Chairman. The Secretariat for the Committee is furnished through the Engineers Joint Council, 29 West 39th Street, New York 18, N. Y. All communications should be directed to the Secretary, U. S. National Committee, World Power Conference, at that address.

The World Power Conference, formed in 1924, is a nongovernment international organization with headquarters in London, England. Its objectives as stated in its constitution, are "the development and peaceful use of energy resources to the greatest benefit of all, both nationally and internationally by: (1) Considering the potential resources and all the means of production of energy in all their aspects; (2) collecting and publishing data on energy resources and their utilization; and (3) holding conferences of those concerned in any way with surveying, developing, and using energy resources." The Conference's International Executive Council, whose present chairman is Sir Vincent de Ferranti, Hon. Mem. ASME, of England, meets annually in various cities of the world to carry on the continuing business of the organization. Plenary Meetings of the World Power Conference are held every six years and Sectional Meetings every two years.

Membership in a National Committee is not a prerequisite to participation in the technical meetings of the World Power Conference, but all participants must register through their National Committees. Interested parties in the United States should write to the U. S. National Committee for any information desired on plans for participation in the Melbourne Meeting. Copies of the technical program are now available and registration forms for attendance may be obtained sometime in 1961 when they are received from the Australian National Committee.

MEETINGS OF OTHER SOCIETIES

● IN THE UNITED STATES

June 18–23

Forest Products Research Society, 15th annual meeting, Kentucky Hotel, Louisville, Ky.

June 18–23

AIEE, summer general meeting, Cornell University, Ithaca, N. Y.

June 12–23

AIEE, pulp and paper conference, University of Western Michigan, Kalamazoo, Mich.

June 25–28

American Society of Agricultural Engineers, annual meeting, Iowa State University, Ames, Iowa.

June 25–30

ASTM, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 26–28

Institute of Radio Engineers, national convention on military electronics, Shoreham Hotel, Washington, D. C.

June 26–28

ASHRAE, 68th annual meeting, Denver Hilton Hotel, Denver, Colo.

June 26–30

American Society for Engineering Education, 69th annual meeting, University of Kentucky, Lexington, Ky.

June 26–30

AIEE, aerospace transportation conference, Benjamin Franklin Hotel, Philadelphia, Pa.

June 28–30

Joint Automatic Control Conference, sponsored by ASME, IRE, AIChE, ISA, AIEE, University of Colorado, Boulder, Colo.

July 4–7

NSPE, annual meeting, Olympic Hotel, Seattle, Wash.

July 19–21

AMA, second national forum on simulation (business games), AMA Academy, Saranac Lake, N. Y.

● IN EUROPE

June 9–17

European Convention of Chemical Engineering and ACHEMA 1961, Frankfurt am Main, Germany.

June 12–16

First International Conference on the Mechanics of Soil-Vehicle Systems, sponsored by the U. S. Army Research Office; Land Locomotion Laboratories, Ordnance Tank Automotive Command; and the Technical Corps of Motorization of the Italian Army, to be held at the Turin Institute of Technology, Torino, St. Vincent, Italy.

June 19–23

Fourth Plansee Seminar on powder metallurgy in nuclear engineering, sponsored by Metallwerk Plansee, to be held in Reutte, Tyrol, Austria.

June 19–24

International meeting on heat transfer, sponsored by the Institut Francais des Combustibles et de l'Energie, to be held in Paris, France.

June 26–July 1

Second International Measurement Conference (IMEKO), Engineering Societies Building, and separately organized international measurement conference, Budapest, Hungary.

July 30–August 6

International Symposium on the Durability of Concrete, prepared by the Czechoslovak Academy of Sciences, Institute of Theoretical and Applied Mechanics, within the framework of The Permanent Committee of Réunion Internationale des Laboratories d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM); to be held in Prague.

August 21–31

United Nations Conference on New Sources of Energy; and an industrial-commercial exhibition of equipment showing developments in solar, wind, and geothermal energy fields, organized by Rassegna Internazionale Elettronica, both in Rome, Italy.

August 23–26

Institute of Management Sciences, eighth annual international meeting, Palais des Congres, Brussels, Belgium.

September 26–29

International Meeting on Heavy Forging, organized by the Camera di Commercio, Industria e Agricoltura with the co-operation of the Associazione Italiana di Metallurgia, to be held in Terni, Italy.

November 16–25

Hungarian Scientific Society for Mechanical Engineering, international festival of scientific and technical films for mechanical engineering, Budapest, Hungary.

● IN CANADA

June 5–8

Instrument Society of America, international instrument-automation conference and exhibit, Royal York Hotel and Queen Elizabeth Hall, Toronto, Ont.

June 6–8

ISA, summer instrument-automation conference, Royal York Hotel and Queen Elizabeth Hall, Toronto, Ont.

June 14

Society of Plastics Engineers, regional technical conference on "Plastics in Packaging," Sheraton Mount Royal Hotel, Montreal, Que.

October 19–November 7

The Iron and Steel Institute, special meeting in the U. S. and Canada.

● IN JAPAN

November 6–11

Society of Chemical Engineers, Japan, 25th anniversary congress exhibition, Sankei Hall, Tokyo, Japan.

(*For ASME Coming Events, see page 122.*)

United Engineering Center as it appeared early in May. The completely air-conditioned building will be ready for occupancy in August.

View on East 47th St. side shows building virtually completed. Workmen put finishing touches to interior.

memo

UNITED ENGINEERING CENTER

TO: ALL ASME MEMBERS

FROM: W. H. BYRNE, President, ASME

Completion of the new home of ASME in the United Engineering Center is cause for celebration. We move in August. It is also cause for grave concern, because ASME has not yet been able to meet its share of the building cost. It is also cause for concern because the names of so many good ASME members will be missed when we start compiling the Honor Roll of Contributors.

Many have not given — two out of every three! This message is a direct request to that majority to get behind this project with a substantial gift.

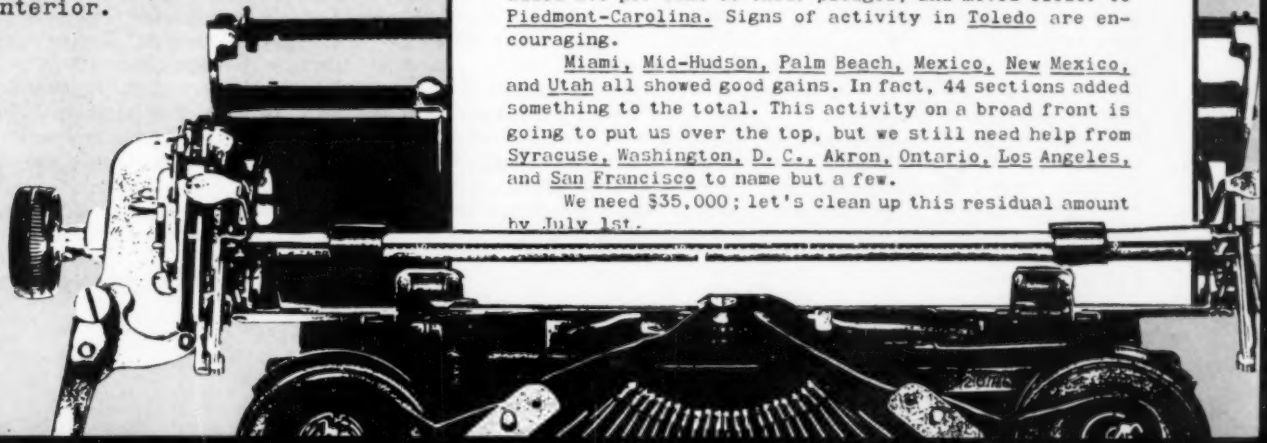
This month we welcome Cleveland to the ranks of 100 percenters. Fort Wayne is still stuck, $9 below the goal. In fact, Gulf Coast has turned in an excellent month, is now ahead of Fort Wayne, and has only $5 to go to achieve quota. Nice going, Gulf Coast, we hope you will be well over the top by the Summer Annual meeting. The same can be said for No. Alabama-Mississippi, with only $30 to go. It appears that the ranks of the 100 percenters will take a big jump next month.

Worcester turned in the prize for the month, adding $1200 to their pledges, and placing them just over 125 per cent of quota, the fourth best performance in the Society. Waterbury cannot afford to rest on its oars much longer, if they hope to retain top spot.

Louisville added $545 to their total and moved up 13.7 percentage points, an outstanding job. Greenville added 2.3 per cent to their pledges, and moved closer to Piedmont-Carolina. Signs of activity in Toledo are encouraging.

Miami, Mid-Hudson, Palm Beach, Mexico, New Mexico, and Utah all showed good gains. In fact, 44 sections added something to the total. This activity on a broad front is going to put us over the top, but we still need help from Syracuse, Washington, D. C., Akron, Ontario, Los Angeles, and San Francisco to name but a few.

We need $35,000; let's clean up this residual amount by July 1st.



Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME Oil and Gas Power Conference and Exhibit Draws Large Attendance in New Orleans

More than 500 attended the 33rd annual Oil and Gas Power Conference and Exhibit held in New Orleans, La., at the Jung Hotel, April 9–13, 1961. The four days of technical sessions and exhibit were sponsored by the ASME Oil and Gas Power Division. Twenty-five companies participated in the exhibition which also was well attended.

Technical Sessions. Air-fuel ratios and the attendant problems of wider fuel tolerance and efficient utilization of fuel received attention in approximately half of the papers presented. There were no missile-glamorous attractions—although a 900-bhp marine diesel represented an achievement in ruggedness and serviceability for a $4\frac{1}{2}$-lb-per-hp package. There was also a multifuel diesel engine capable of burning combat gasoline without sacrifices in cold-weather operating characteristics or fuel economy.

Except for a session on automation and automatic operation, most of the papers represented good solid solutions to engineering design or operation problems. There was a paper on the proper selection, operation, and maintenance of packing materials for reciprocating-compressor rods. A resilient couple was developed to overcome an operating-speed resonance that occurred in a diesel-engine drive.

The fuel-air-ratio problem on dual-fuel engines used in pipeline service was solved by reducing combustion-air quantity when it was operated as a gas diesel to about 75 per cent of that required when operating as an oil diesel. Fuel savings of up to 20 per cent were achieved for these variable-load variable-speed engines by changes in pilot-fuel timing and quantity as a result of speed changes. Air-fuel ratios were also altered with changes in the ambient temperature.

The multifuel diesel capable of burning combat gasoline was otherwise of conventional design. The special features which made it possible to burn the combat gasoline included: (*a*) A hypercycle combustion system (fuel is sprayed against the wall of a spherically shaped combustion chamber, located in the crown of the piston, and swirling air provides the correct mixture for burning the slowly evaporating fuel); (*b*) a water-jacketed intake manifold and a manifold flame heater for cold starting.

Further emphasis on efficiency was given in a paper describing a method for evaluating the scavenging efficiency of a two-cycle diesel engine; and another on turbocharger selection, matching, and development for two-cycle, spark-ignition engines. The importance of satisfactory engine-intake and exhaust installations, as related to the optimum air-fuel ratio, was stressed elsewhere.

Greater fuel tolerance brings corrosion and wear problems, but it was pointed out that very low rates of cylinder wear can be attained in large diesel engines operating on heavy fuel if: (*a*) Chrome-plated liners are used, (*b*) chrome with channel-type porosity is employed, (*c*) oil grooves are properly designed, (*d*) tailor-made emulsion lubrication is used.

Test results of burning various fuels and mixtures in 4-cycle engines, including the effects of changing the air-fuel and compression ratios were described.

Faced with the possibility of a fuel shortage in a National Emergency, the Navy would be unable to use only straight-run diesel fuel, as it has for many years. The policy was originally adopted to insure storage stability for many years and under extremes of temperature. To permit the use of blends of straight-run and cracked distillates it was necessary to develop a method of predicting storage stability. This was done.

In the session on automation and automatic controls, a completely automatic 2950-kw diesel-electric generating station on Nantucket Island, Mass., was described. There are three engines—1250, 1000, and 700-kw—which can be arranged to come on the line in any sequence, providing great flexibility in meeting the widely varying summer and winter loads in this resort area.

Typical gaseous-fuel controls to permit the use of intermittently available waste gases were illustrated, and the current trends in engine-control application were described. The growing stress on safety features in the control system was emphasized.

Inspection Trip. An unusual inspection trip was a 30-mile steamer tour of the Port of New Orleans with its ten miles of coffee, cotton, and banana docks. The tour included some of the picturesque communities on the West Bank of the Mississippi and the $65-million bridge.

Banquet. H. R. Sennstrom, chairman, ASME Oil and Gas Power Division, vice-president, American Bosch Arma Corporation, presided at the Banquet; and George Steven, general manager, Compressor and Engine Division, Worthington Corporation, who is also vice-president and director, Diesel Engine Manufacturer's Association, was toastmaster.

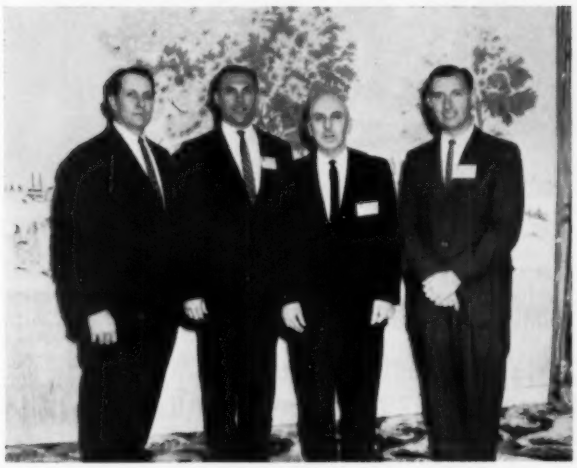
The speaker was Justin Wilson, humorist, of Justin Wilson and Associates, Baton Rouge, La.

Honors and Awards. Citations for outstanding service were presented to Lloyd V. Armstrong, Assoc. Mem. ASME, retired, formerly chief engineer, Gas and Diesel Engine Department, Ingersoll-Rand Company; and Paul H. Schweitzer, Mem. ASME, of Schweitzer & Haussmann.

OGP Speakers Awards were presented to A. N. Addie, Mem. ASME, for his paper "Design and Development of Turbochargers for the General Motors Corporation Series 567 Engines"; and Fred A. Robbins, Mem. ASME, and John W. Lippert of the Koppers Company, Inc., for their paper on "Piston Ring Design and Application Practice for Modern Large-Bore Diesel and Gas Engines."

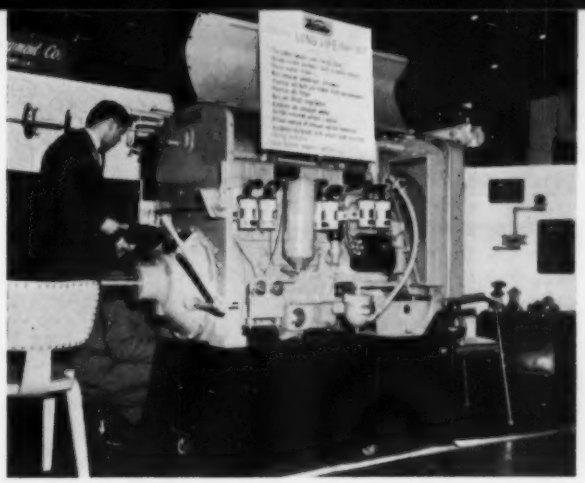
The award of the Division's Special Lecture Committee was presented to

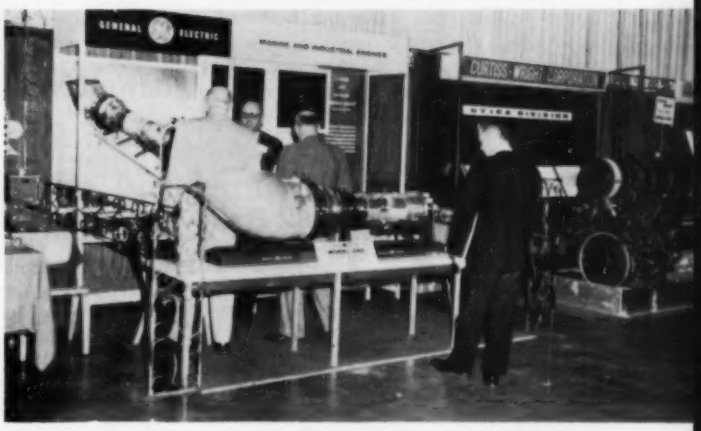
Seen at the Technical Sessions and Exhibits



OGP Speakers Awards presented. **Left to right:** J. W. Lippert and F. A. Robbins of Koppers Company; W. K. Newcomb of Ingersoll-Rand Company and chairman, OGP Honors and Awards Committee; and A. N. Addie of General Motors Corporation. Mr. Newcomb congratulates recipients on the excellence of their papers.

A. H. Jensen, **left,** Vice-President, ASME Region X, presents certificate of merit to outgoing OGP chairman, John C. Gibb, at the conference held in New Orleans. R. H. Sennstrom, **right,** chairman of the OGP Executive Committee, looks on.





Martin A. Elliott, Mem. ASME, director of the Institute of Gas Technology. In his paper on "Fuels of the Future," presented earlier, he attempted to analyze the pattern of fuel use for the next 100 years.

The study began with the realization that within a decade coal has passed from first place in the competitive positions of the three primary energy sources to third place, following crude petroleum and natural gas.

Mr. Elliott concluded that our energy system will continue to be based primarily on fluid fuels, but there will be some change in their source. Since the level of recovery for natural gas is currently high and the ultimate reserves are reasonably well known, peak production can be expected in about 20 or 25 years, followed by a gradual decline.

Both the rate of population growth and the increase in per capita use of energy are expected to decline to zero by the year 2050, compared with an annual growth rate for energy consumption of 3.2 per cent for the period from 1955 to 1975.

It is assumed that the pattern of consumption will not change after 1975 and at that time coal will account for 25.5 per cent (23.5 in 1959), petroleum plus natural gas liquids 44.8 per cent (45.8 in 1959), natural gas 26.5 per cent (26.8 in 1959), and hydropower 3.2 per cent (3.9 in 1959).

Supplemental liquid fuel is expected to be produced from shale and supplemental gaseous fuel from coal. (The cost of producing liquid fuel from oil shale is lower than from coal.)

Information on the place of nuclear energy was considered inadequate by Mr. Elliott, but it is expected to replace 2.5 to 3.75 per cent of conventional energy sources by 1975. Breeder reactors may ultimately supply 5000×10^{18} Btu, compared with 29×10^{18} Btu available from recoverable fossil-fuel resources.

The place of direct-energy-conversion methods is even more of an unknown.

Coal reserves are considered adequate for "considerably more than" 100 years although the cost of production will be higher. Oil-shale resources also are adequate, although it may be necessary to convert some of the lower grades of the shales into liquid fuel.

Availability List—Oil and Gas Power Conference and Exhibit

THE papers in this list are available in separate copy form until February 1, 1962. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including you check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

61—OGP-1 Operation of Dual-Fuel Engines in Pipeline Service, by E. Kelgard

61—OGP-2 Cycle Analysis From Combustion Equations, by L. T. Brinson, Jr.

61—OGP-3 Electrochemical Cylinder Corrosion, by J. M. A. Van Der Horst and W. A. Schultze

61—OGP-4 Trends in Marine Diesel Fuel for the Navy, by E. C. Davis

61—OGP-5 Evolution and Development of a 900-Hp Marine Diesel Featuring Ruggedness and Serviceability in a 4½ Lb/Hp Package, by L. Wechsler, L. Thompson, and E. Tsakiris

61—OGP-6 A Multifuel-Engine Experience, by W. F. Insley

61—OGP-7 Wave Phenomena and Conditioning of Induced Air and Exhaust Gas in the Operation of Internal-Combustion Engines, by B. G. Golden

61—OGP-8 The Way to Automate—A Diesel Utility, by R. D. Hamilton

61—OGP-9 Application of a Resilient Coupling to Avoid Resonance in a Diesel Engine Installation, by A. S. Herman, Jr.

61—OGP-10 Turbocharger Selection, Matching, and Development for Two-Cycle, Spark Ignition Gas Engines, by W. H. Payne, G. H. Bollman, and R. L. Johnson

61—OGP-11 Current Trends in Engine-Control Application, by C. R. Carmichael

61—OGP-12 Automatic Gaseous Fuel Controls, by R. G. Abbott

61—OGP-13 Operation and Maintenance of Metallic-Rod Packings for Reciprocating Compressors, by G. Wilkes, III

61—OGP-14 Performance of Spark Ignition 4-Cycle Engines on Various Fuels, by C. E. Holvenstot

J. D. Quinn, Secretary of M&PE Division, sits between J. R. Aikins, chairman of Program Committee, **left,** and A. G. Thailing, General Chairman of Conference Committee, waiting for Conference to start

New Tools for Maintenance Cost Control

ASME Maintenance and Plant Engineering Conference hears developments in cost reduction

"INCREASED mechanization in industrial plants has greatly increased the share of the product cost that is borne by maintenance groups. As a result, the administrative control of maintenance costs has become increasingly important to management. Frequently, people with technical and craft training do not have an affinity for accounting and cost-control systems, yet these are the people who must control the cost of work, particularly the labor dollar. This paper describes. . ."

The above quote is from the résumé of one of the papers presented at the conference of the Maintenance and Plant Engineering Division of The American Society of Mechanical Engineers, held in Worcester, Mass., April 10–11, 1961, in co-operation with the Society's Worcester Section, and with the participation of the American Institute of Plant Engineers. It states the problem faced by maintenance throughout industry today: How to cut costs to help the plant meet new competition. The theme of the conference was, "Meeting Competitive Prices Through Improved Plant Maintenance."

Maintenance Forum. Beside the ten technical papers, four of which bore directly on this problem, the conference included a forum on meeting the new competition in which five panelists discussed this phase of engineering.

B. G. Evans, manager of Maintenance Departments, Eli Lilly and Company, acted as moderator for the forum. Other panel members included: W. M. Kiel and John Vonderheide, General Electric Company; C. E. Knight, Monsanto Chemical Company; A. F. Hardy, Jr., Norton Company; and W. F. Hartling, Union Carbide and Chemical Company. Questions and topics for discussion were solicited during previous sessions of the conference.

At the Welcome Luncheon, H. E. Hollensbe presided. He is vice-chairman of the ASME Maintenance and Plant Division and editorial consultant, Plant Management and Engineering, St. Joseph, Mich. The speaker was Fred G. Fryberger, president of AIPE. Speaking on the topic, "The Years Ahead," he said the challenges of the years ahead will be our ability to keep up with the increased demands on our technical know-how. Among the challenges he listed were: New products, tools, machines, materials, methods, cost reduction to meet foreign competition, the national water supply, and design responsibility with "computers beginning to outstrip the slide rule teams in major plant design."

That evening, K. P. Powers presided at the banquet. He is chairman of the MPE Division, and staff engineer, Gulf Research and Development Company, Pittsburgh, Pa. Arthur Bronwell, president of Worcester Polytechnic Institute, served as toastmaster.

The main speaker was William Clew, young journalist of Worcester who has visited Antarctica, and who gave an informative talk on the work done in the Antarctic Region during the IGY. He reminded his listeners that Antarctica is the last uncharted area in the world, that it has twice the land area of the United States. It is the new frontier.

On the second day of the conference, Jose R. Canal, chairman of the Worcester Section, presided at the luncheon. He is project engineer at Wyman Gordon

Company. The speaker was Norman Blodgett, a patent attorney with the Morgan Construction Company of Worcester. He gave a lively talk on patents, with slides showing a number of patents that had made history. He showed the famous "Selden patent" on the automobile, the patent which had the automobile industry in its grasp until Henry Ford successfully defeated it in court.

Maintenance in Action. Some 50 engineers of the conference went on the inspection trip to the Norton Company, one of the largest manufacturers of abrasives, grinding wheels, grinding and lapping machines, and encapsulating equipment. Extensive facilities devoted solely to factory maintenance made this a rewarding trip.

Altogether, more than 140 engineers, several from Canada and India, attended this fourth annual conference of the Maintenance and Plant Division.

Availability List—Maintenance and Plant Engineering Conference

THE papers in this list are available in separate copy form until Feb. 1, 1962. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

61—MPE-1 Reduction of Maintenance Cost With "Teflon" Fluorocarbon Resins, by R. D. Pillsbury, Jr.

61—MPE-2 Fuels and Lubricants for Industrial Plant Trucks, by N. T. Brenner

61—MPE-3 A New Tool for Maintenance Cost Control, by E. A. Rachal and W. E. Dougher

61—MPE-4 Lubrication Standards. Are They Really Necessary? by R. C. Garretson

61—MPE-5 The Role of Lubrication in Preventive Maintenance Engineering, by T. R. Witt

61—MPE-6 The Real Facts About Vinyl Maintenance Coatings, by W. H. McKnight

61—MPE-7 Maintenance Cost Reduction and Control in a Paper Mill, by C. V. Clarke

61—MPE-8 Evaluation of the Safety Aspects of Window-Glazing Materials in Industry, by W. E. Seuberling

61—MPE-9 Simplified Preventive Maintenance Scheduling Systems, by K. M. Smith

61—MPE-10 A Maintenance Improvement and Cost-Control Program, by A. Chapman

ASME Metals Engineering Conference, in Pittsburgh, Features New Roles for Metals

- Conference provides insight on the tailoring of metals to meet the demands of today's machine designers
- Pittsburgh engineers honored

"LOOK around at the hardware that assures the security of our country," said ASME President William H. Byrne, "at the magnificent aircraft that brought some of us two or three thousand miles in a few hours, at the probes that are being sent into space—and try to imagine what life would be like without the kind of metals engineering that you men do."

Mr. Byrne, addressing the annual Conference of the Metals Engineering Division of The American Society of Mechanical Engineers, April 23–25, 1961, at the Penn Sheraton Hotel, Pittsburgh, Pa., pointed out to the luncheon audience a few items of what ASME does in this area.

There is the metals engineering handbook series which he called "a virtual bible for men practicing in the field." He mentioned the ASME research committees, especially the committees dealing with contact fatigue, plastic flow of metals, prevention of fracture in metals, the effect of radiation on materials for nuclear installations, and the long-standing ASTM-ASME committee on the effect of temperatures on the properties of metals. E. W. Jacobson, Fellow ASME, and chief design engineer, Gulf Research & Development Company, was toastmaster at the luncheon at which Mr. Byrne spoke.

A hundred engineers engaged in this field met to hear a program of notable significance to engineers and metallurgists. In addition to the papers preprinted by ASME and listed at the end of this report, there were papers on "Materials and Atomic Energy," "Materials and the Space Program," and "Materials for Power Conversion."

Tailoring Metals to Meet Design Requirements. Emphasizing the need for tailoring metals to meet design requirements of the engineer, the Conference was opened with a session exploring the new metallic requirements arising from the dawning atomic, space, and power-conversion age. D. A. Douglas, Jr., of Oak Ridge National Laboratories discussed materials for atomic energy applications. Warren Eding of the National Academy of Science chose to discuss materials as related to the space program. J. C. R. Kelly, Jr., of Westinghouse Research Laboratories said that materials needed for the new age of power conversion, contrary to those in conventional power plants, require the

At the ASME Metals Engineering Conference, Pittsburgh, Pa., April 23–25. **Left to right:** C. B. Cochran, Chairman, ASME Pittsburgh Section and Vice-Chairman, Metals Engineering Division Conference, Peter Loftus Corporation, Pittsburgh, Pa.; ASME President W. H. Byrne; E. W. Jacobson, chief design engineer, Gulf Research & Development Company, who received a certificate designating him a Fellow of ASME; N. H. Eckler, design engineer, also of Gulf R&D, past-chairman, Pittsburgh Section; T. W. Eichelberger, Westinghouse Research Laboratory, member, Metals Engineering Division Executive Committee and General Chairman of the Conference.

ability to withstand extremely high operating temperatures but not to bear heavy loads. Among such materials he noted that for thermoelectric power, scientists were studying unusual ceramics, for thermionics the use of tungsten, for fuel cells certain oxides of glass, and for magnetic hydrodynamics magnesium and zirconium oxide were being investigated.

During the second session D. E. Martin, General Motors Research, led off with a discussion on energy criterion of low cycle fatigue (Paper No. 61—Met-4) in which a new method was advanced for determining the value of the constant "C" in the plastic strain-cycle life equation. He was followed on the rostrum by P. E. Bennett who with G. M. Sinclair reported the work done at the University of Illinois on the time and temperature dependence of the upper yield point of iron (Paper No. 61—Met-1). They reported that torsion tests conducted on ingot iron using strain rates of 12.5, 0.25, and 0.0001/sec over a range of 77 to 525 K. The results showed that the yield strength exhibits a rapid increase as the temperature is lowered and yield strength also increases as the strain rate is increased. The investigation confirmed data secured from tensile tests run by others—that state of stress is an important factor in determining whether a material will behave in a ductile or brittle fashion. H. G. Landau of Columbia University, E. H. Hess of Frankford Arsenal, and E. Z. Zwicky of General Electric combined their talents in a paper on theoretical and experimental residual stresses in quenched steel cylinders (Paper No. 61—Met-6). Stresses were determined using equations from previous work. These were compared with measured stresses on cylinders which had been subcritically quenched. Satisfactory agreement between computed and measured stresses was obtained.

Opening Tuesday's program, J. Bressanelli, Crucible Steel Company, and J. Hoke, Pennsylvania State University, contributed a study of the effects of interrupted quenching procedures on the properties of 410 stainless steel (Paper No. 61—Met-5). The study was made to determine how much the impact strength can be improved by certain improvements in heat-treating methods. They found rapid cooling such as occurs during oil quenching was detrimental, but air cooling resulted in an improvement of impact strength.

A revolutionary new concept of design for lightweight, high-temperature nuclear power-plant systems for use in space exploration was disclosed in the second paper. G. H. Rowe, A. E. Gemma, and R. J. Spahl, all of Pratt & Whitney Aircraft Division of United Aircraft, told of a developing technology of high-temperature strength of materials which eventually would permit the use of very thin metal structures in liquid-metal heat-transfer systems. These light structural members would operate for long periods of time with minimum deformation. Because of complex stress states in such members much more work must be done by colleges and industry in resolving the current theories of high-temperature deformation behavior. As an example of the potential benefits of this design concept it was stated that based on recently published data on nuclear power plants, a saving in weight of 10 per cent in a 1000 kw power supply for ion propulsion could result in a cost reduction of up to $15 million for one launch.

The afternoon session on the second day of the conference was devoted to a lively discussion of "Metals Research Now and in the Future." Paul W. Marshall of U. S. Steel Corp. Applied Research Laboratory pulled back the curtain to reveal new structural and special steels produced by research and presented a view of future progress in structural shapes and analyses for that metal. C. L. Brooks of Reynolds Metal discussed new alloys of aluminum and their application in construction, the motor car field, industry, and the home. If the aluminum is successfully developed, Mr. Brooks implied that this one market alone could absorb the entire ingot production of the aluminum industry. F. M. Richmond of Universal Cyclops Steel described the development of the techniques and the facilities for producing and working alloy steels in an atmosphere of argon in order to secure steels of high purity free from dissolved gases. A complete small scale mill for melting and rolling the alloy steels in an atmosphere of argon has been developed. The operators in this laboratory scale mill work in air-conditioned "space suits." Mr. Richmond discussed future plans for developing a laboratory working under a complete vacuum. This appears to be the next step in order to secure the purity of product they are seeking. John T. Eash, The International Nickel Company, discussed recent developments in high tensile nickel-alloy steels with yield strengths in the range of 250,000 psi. These steels were said to exhibit good elongation and notch toughness at reasonably low temperatures.

Metals in Medicine. At the Monday luncheon Dr. Patrick Lang held his audience spellbound with his discourse on the seldom publicized subject "Metal Implants in Surgery." Dr. Lang said that the principles of the "H" and "I" beams are being successfully applied in metallic shapes, implanted during surgery to strengthen the human body, in part as a result of research at the University of Pittsburgh where 50 to 60 alloys and pure metals are being investigated to secure improved combinations of strength, long life, and body-tissue reaction. Besides improvements in design of implants Dr. Lang revealed that significant progress is being made in overcoming damage caused by the body, which he termed more corrosive than sea water, and causing implants to fail. Certain titanium alloys might solve this problem.

A dramatic sidelight of Tuesday's luncheon was the association of two nationally known smoke-control leaders. ASME President William H. Byrne, featured Conference speaker at the luncheon, presented (in absentia) a special ASME Award for 65-year membership and service to the Society to 92-year old Dr. Sumner B. Ely, former Smoke Control Adminstrator for the City of Pittsburgh. Mr. Byrne developed several combustion processes and was organizer and director of New York's first Housing and Building Smoke Control Bureau. Following this award, Mr. Byrne presented E. W. Jacobson, Chief Design Engineer, Gulf Research & Development Company, with a certificate elevating him to the grade of Fellow.

Availability List—Metals Engineering Conference

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61—Met-1 An Analysis of the Time and Temperature Dependence of the Upper Yield Point in Iron, by P. E. Bennett and G. M. Sinclair

61—Met-2 Effects of Specimen Size and Notch Acuity on the Brittle Fracture Strength of a Heat-Treated Steel, by S. Yukawa and J. G. McMullin

61—Met-3 Elastic and Creep Characteristics of a Class of Shell Closures With Constant Stress Ratio, by A. E. Gemma, G. H. Rowe, and R. J. Spahl

61—Met-4 An Energy Criterion for Low-Cycle Fatigue, by D. E. Martin

61—Met-5 Effects of Interrupted Quenching Procedures on Properties of Type 410 Stainless Steel, by J. Bressanelli and J. Hoke

61—Met-6 Theoretical and Experimental Residual Stresses in Quenched Steel Cylinders, by H. C. Landau, E. H. Hess, and E. E. Zwicky, Jr.

Five Engineering Societies to Participate in Joint Automatic Control Conference Program

RECENT advances in automatic control will be discussed at the Second Joint Automatic Control Conference, June 28–30, 1961, at the University of Colorado, Boulder, Colo. To insure comprehensive coverage of significant progress five leading societies have provided active sponsorship and programming support—ASME, AIChE, AIEE, IRE, and ISA.

Attendance of 1000 control engineers and scientists from the United States and Canada is expected to fill the housing facilities at Boulder. Advance registration and reservation forms for housing and social functions are available from the Meetings Manager, ISA, 313 Sixth Avenue, Pittsburgh 22, Pa.

The Joint Automatic Control Conference was conceived to avoid duplicate, redundant, and overlapping control meetings. Because this widescale assemblage of control personnel occurs only at the JACC, other related meetings are being scheduled to precede the main forum by one and two days. Among these ancillary meetings, two are firm:

1 The Simulation Techniques Subcommittee, AIEE Feedback Control Systems Committee, will conduct a panel on simulation techniques, Tuesday, June 27, 1961. Topics will range from specific techniques, such as simulating samplers and quantizers to simulating broad industrial and economic systems.

2 The Nonlinear Control Theory Committee, AIEE, will organize a workshop on dynamic programming, Tuesday, June 27, 1961. Topics will include adaptive control, sampled data, and industrial process control.

Following is the program for the regular JACC sessions:

▶ WEDNESDAY, JUNE 28

Formal Opening—Plenary Meeting
Session 1 **10:00 a.m.**

Introductory Remarks:

R. K. Adams, Chairman of Conference, Oak Ridge National Lab., Oak Ridge, Tenn.

H. M. Paynter, General Program Chairman, Massachusetts Institute of Technology

D. A. Rodgers, Local Arrangements Chairman, Consolidated Systems Corp.

Award of AACC Prize for 1960 JACC Paper:

W. D. Archibald, Chairman, Awards Committee, American Automatic Control Council, Energy Control Co., New York

Invited Addresses:

Heuristic Aspects of Adaptive Control, by *M. L. Minsky*, M.I.T.

Modern Research in Automatic Control, by *K. Chen*, Westinghouse Elec. Corp., Pittsburgh, Pa.

Theory of Optimization
Session 2 **2:00 p.m.**

2.1: **The Structure of Optimum Control Systems,** by *B. Friedland*, Columbia Univ. (ASME Paper No. 61—JAC-1)

2.2: **On the Existence of Optimum Controls,** by *L. Markus* and *E. B. Lee*, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. (ASME Paper No. 61—JAC-2)

2.3: **Optimal Pursuit Strategies in Discrete-State Probabilistic Systems,** by *J. H. Eaton* and *L. A. Zadeh*, Univ. of California (ASME Paper No. 61—JAC-11)

2.4: **On a Property of Optimal Controllers With Boundedness Constraints,** by *H. L. Groginsky*, Raytheon Co., Wayland, Mass.

Hydraulic and Pneumatic Control
Session 3 **2:00 p.m.**

3.1: **Design of Hydraulic Servo With Improved Bandpass Characteristics When Driving a Resonant Mechanical Load,** by *W. Seamone*, Johns Hopkins Univ.

3.2: **The Linear Properties of Pneumatic Transmission Lines,** by *N. B. Nichols*, Taylor Instrument Co., Rochester, N. Y.

3.3: **Hydraulic Control of Acoustic-Test Siren Rotors Using Analog-Digital Techniques,** by *F. D. Ezekiel*, American Measurement and Control, Inc., Waltham, Mass.

3.4: **A Systems Approach to High-Accuracy Fluid-Control Valving,** by *R. Henke*, Racine Hydraulics and Machinery, Inc., Racine, Wis.

Economic Parameters in Process Control
Session 4 **2:00 p.m.**

4.1: **Cost Models for Systems Engineering,** by *H. Chestnut*, General Electric Co., Schenectady, N. Y. (Paper No. AIEE-JACC-61-707)

4.2: **Outline of the Future Role of Feed-Forward Control in the Chemical Industry,** by *S. Calvert*, Univ. of Michigan, and *G. Coulman*, Case Inst. of Tech.

4.3: **Incentives for Computer Control in the Chemical-Process Industries,** by *T. Q. Eliot* and *D. R. Longmire*, Texas Butadiene and Chemical Corp., Houston, Texas

Mackey Auditorium 8:00 p.m.

Invited Address:

Engineers' Responsibility in the Effects of Automation on Society, by *Ewan Clague*, Commissioner, Bureau of Labor Statistics, U. S. Department of Labor

▶ THURSDAY, JUNE 29

Session 5 Optimal Switching 9:00 a.m.

5.1: **A Switching Criterion for Certain Time-Optimal Regulating Systems,** by *E. R. Rang*, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. (ASME Paper No. 61—JAC-12)

5.2: **Time Optimal Control of Nonlinear Processes,** by *E. B. Lee*, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. (ASME Paper No. 61—JAC-3)

5.3: **A General Iterative Technique for Optimal Control Systems Subject to Saturation,** by *Y. C. Ho*, Harvard Univ. (ASME Paper No. 61—JAC-10)

5.4: **A Minimal Time Discrete System,** by *C. A. Desoer* and *J. Wing*, Univ. of California

Aerospace Vehicle Control—1
Session 6 **9:00 a.m.**

6.1: **Design Considerations of Inertia Wheel Systems for Attitude Control of Satellite Vehicle,** by *R. E. Mortensen*, Space Technology Labs, Inc., Los Angeles, Calif.

6.2: **Gyroscopic Coupling in Space Vehicle Attitude Control Systems,** *R. H. Cannon, Jr.*, Stanford Univ., Stanford, Calif. (ASME Paper No. 61—JAC-8)

6.3: **Derived Rate Increment Stabilization: Its Application to the Attitude Control Problem,** by *H. C. Vivian* and *J. C. Nicklas*, Jet Propulsion Lab, Pasadena, Calif. (ASME Paper No. 61—JAC-9)

Session 7 Process Dynamics 9:00 a.m.

7.1: **A Finite-State Model for Highly Asymmetric Residence-Time Distributions,** by *R. J. Adler* and *R. B. Hovorka*, Case Inst. of Tech.

7.2: **Concentration Dynamics in Tubular Flow Systems,** by *L. T. Fan* and *Y. K. Ahn*, Kansas State Univ.

7.3: **Transfer Functions of Heat Exchangers,** by *J. P. Hsu* and *N. Gilbert*, Univ. of Cincinnati

Session 8 Optimal Switching—2 2:00 p.m.

8.1: **Theory and Design of High-Order Bang-Bang Control Systems,** by *M. Athanassiades* and *O. J. M. Smith*, Univ. of California

8.2: **The Synthesis of Quasi-Stationary Optimum Nonlinear Control Systems: Part 1. Synthesis Considerations; Part 2, Extension in Mechanization,** by *C. T. Leondes*, Univ. of California, and *P. Chandakat*, Royal Thai Navy, Bangkok, Thailand (AIEE-JACC-61-705/706)

8.3: **Optimal Control Methods for On-Off Sampling Systems,** by *W. L. Nelson*, Bell Telephone Labs, Inc., Whippany, N. J. (ASME Paper No. 61—JAC-6)

8.4: **Minimum Time Control of Second Order Pulse-Width-Modulated-Sampled-Data Systems,** by *E. Polak*, Univ. of California (ASME Paper No. 61—JAC-7)

Aerospace Vehicle Control—2
Session 9 **2:00 p.m.**

9.1: **Model Feedback Applied to Flexible Booster Control,** by *G. E. Tait* and *W. K. Waymeyer*, Douglas Aircraft Co., Inc., Santa Monica, Calif.

9.2: **Can Electric Actuators Meet Missile Control Requirement?** by *G. C. Newton, Jr.*, and *R. W. Rasche*, M.I.T. (AIEE-JACC-61-711)

Preprints

PREPRINTS of ASME and AIEE papers will be available at the meeting as well as from the headquarters of these societies. Orders should refer to parenthesized code numbers appearing after paper title in the advance program: Cost of each preprint to members will be 50 cents; nonmembers, $1.

The Transactions of the IRE Professional Group on Automatic Control will include all of the IRE papers to be presented at the 1961 JACC.

Availability of ASME Papers

Only numbered ASME papers in this program will be available in separate copy form until April 1, 1962 Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

9.3: **Terminal Control System Applications,** by *R. K. Smyth* and *E. A. O'Hern*, North American Aviation, Inc., Downey, Calif.

Automatic Control Applications
Session 10 **2:00 p.m.**

10.1: **Direct-Cycle Nuclear Power-Plant Stability Analysis,** by *D. Buden* and *R. F. Miller*, Gen. Elec. Co., Cincinnati, Ohio

10.2: **The Application of Dead-Time Compensation to a Chemical Reactor for Automatic Control of Production Rate,** by *D. E. Lupfer* and *M. W. Oglesby*, Phillips Petroleum Co., Bartlesville, Okla.

10.3: **Description of a Digital Speed-Regulating System,** by *E. C. Fox*, Westinghouse Elec. Corp., East Pittsburgh, Pa., and *J. Dobois*, Westinghouse Electric Corp., Buffalo, N. Y. (AIEE-JACC-61-714)

10.4: **Measuring and Classifying Haze in Plate Glass With an Automatic Hazemeter,** *B. W. Preston*, Ford Motor Co., Detroit, Mich.

Harvest House **6:00–9:00 p.m.**
Cocktails, Banquet, Entertainment

▶ FRIDAY, JUNE 30

Adaptive Control Systems
Session 11 **9:00 a.m.**

11.1: **A Parameter Perturbation Adaptive Control System,** by *R. J. McGrath, V. Rajaraman*, and *V. C. Rideout*, Univ. of Wisconsin

11.2: **Transfer Function Tracking and Adaptive Control Systems,** by *N. N. Puri* and *C. N. Weygandt*, The Moore School of Electrical Engineering, Univ. of Pennsylvania

11.3: **Adaptive Servo Tracking,** by *A. I. Talkin*, Diamond Ordnance Fuze Labs, Washington, D. C.

11.4: **An Adaptive Three-Mode Controller for the Process Industries,** by *W. B. Field*, Union Carbide Olefins Co., South Charleston, W. Va.

Nonlinear Control Systems
Session 12 **9:00 a.m.**

12.2: **A Modified Lyapunov Method for Nonlinear Stability Analysis,** by *D. R. Ingwerson*, Sperry Gyroscope Co., Sunnyvale, Calif.

12.2: **Some Recent Advances in Analysis and Synthesis of Nonlinear Systems,** by *A. A. Wolf*, Stromberg-Carlson Co., Rochester, N. Y. (AIEE-JAC-61-713)

12.3: **Nonlinear Controllers,** by *J. C. Webb*, Celanese Corp., Corpus Christie, Texas, and *H. T. Bates*, Kansas State Coll.

Luncheon Meeting **12:00 Noon**

Informal Panel Report—Automatic Control in Japan

Moderator: *J. Gibson*, Purdue Univ.

U. S. Automatic Control Team

Statistical Design Considerations
Session 13 **9:00 a.m.**

13.1: **Signal Stabilization of a Control System With Random Inputs,** by *R. Oldenburger* and *R. Sridhar*, Purdue Univ. (AIEE-JACC-61-712)

13.2: **The Use of a Mean-Weighted Square Error Criterion for Optimum Filtering on Nonstationary Random Processes,** by *K. Sahara* and *G. J. Murphy*, Northwestern Univ.

13.3: **Stability of a Nonlinear Feedback System in the Presence of Gaussian Noise,** by *R. Oldenburger* and *R. Sridhar*, Purdue Univ. (ASME Paper No. 61—JAC-5)

13.4: **A General Performance Index for Analytical Design of Control Systems,** by *Z. V. Rekasius*, Purdue Univ.

Special Topics in Control
Session 14 **2:00 p.m.**

14.1: **On Periodic Modes of Oscillation in Pulse-Width-Modulated Feedback Systems,** by *E. I. Jury* and *T. Nishimura*, Univ. of California (ASME Paper No. 61—JAC-4)

14.2: **Design of Noninteracting Control Systems Using Bode Diagrams,** by *K. Chen, R. A. Mathias*, and *D. M. Sauter*, Westinghouse Research Labs, Pittsburgh, Pa. (AIEE-JACC-61-708)

14.3: **A Graphical Method for Finding the Frequency Response of Nonlinear Closed-Loop Systems,** by *A. S. McAllister*, Ithaca, N. Y. (AIEE-JACC-61-710)

14.4: **Optimizing Control of Single-Input Extremum Systems,** by *J. S. Frait* and *D. P. Eckman*, Case Inst. of Tech. (ASME Paper No. 61—JAC-13)

14.5: **Sensitivity Considerations for Time-Varying Sampled-Data Feedback Systems,** by *J. B. Cruz, Jr.*, Univ. of Illinois

Process and Control Nonlinearities
Session 15 **2:00 p.m.**

15.1: **Fast Analog Computer Techniques for Design of Controllers for Nonlinear Systems,** by *G. J. Fiedler* and *J. J. Landy*, Sverdrup and Parcel and Associate, Inc., St. Louis, Mo. (AIEE-JACC-61-715)

15.2: **On Stabilization of Feedback Systems Affected by Hysteresis Nonlinearities,** by *A. K. Mahalanabis*, Univ. Coll. of Tech., Calcutta, India (AIEE-JACC-61-709)

15.3: **Stability of Servomechanisms With Friction and Stiction in the Output Element,** by *P. K. Bohacek* and *F. B. Tuteur*, Yale Univ. School of Engineering, New Haven, Conn.

15.4: **The Motion of Systems Under Square Law Damping,** by *W. H. Baier*, Illinois Inst. of Tech. Center, Chicago, Ill.

Time Series and Process Identification
Session 16 **2:00 p.m.**

16.1: **System Impulse Response Identification Based Upon Short Normal Operating Records,** by *R. B. Kerr* and *W. H. Surber, Jr.*, Princeton Univ.

16.2: **Some Techniques of Linear System Identification Using Correlating Filters,** by *W. W. Lichtenberger*, Univ. of Illinois

16.3: **Digital Computer Analysis of Closed-Loop Systems Using Number Series Approach,** by *R. K. Adams*, Oak Ridge National Lab, Oak Ridge, Tenn. (AIEE-JACC-61-704)

ASME COMING EVENTS

June 11–14, 1961
ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

June 14–16, 1961
ASME Applied Mechanics Conference, Illinois Institute of Technology, Chicago, Ill.

June 19–21, 1961
Heat Transfer and Fluid Mechanics Institute, University of Southern California, Los Angeles, Calif.

August 28–30, 1961
ASME West Coast Conference of Applied Mechanics, University of Washington, Seattle, Wash.

August 28–September 1, 1961
Second International Heat Transfer Conference, University of Colorado, Boulder, Colo.

September 14–15, 1961
ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24–27, 1961
ASME-AIEE National Power Conference, St. Francis Hotel, San Francisco, Calif.

September 24–27, 1961
ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

October 4–6, 1961
ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 17–18, 1961
ASME Bulk Solid Handling Symposium, Pick Nicollet Hotel, Minneapolis, Minn.

October 17–19, 1961
ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26–December 1, 1961
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

January 24–26, 1962
ASME Second Symposium on Thermophysical Properties, Princeton University, Princeton, N. J.

March 4–8, 1962
ASME Gas Turbine-Process Industries Conference and Products Show, Shamrock Hilton Hotel, Houston, Texas

April 5–6, 1962
ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9–13, 1962
ASME Metals Engineering Division—AWS Conference, Sheraton Cleveland Hotel, Cleveland, Ohio

April 10–11, 1962
ASME-AIEE Railroad Conference, King Edward Hotel, Toronto, Canada

April 30–May 3, 1962
ASME Design Engineering Conference and Concurrent Show, Chicago Exposition Center, Chicago, Ill.

May 7–8, 1962
ASME Maintenance and Plant Engineering Conference, Royal Orleans Hotel, New Orleans, La.

June 4–8, 1962
Nuclear Congress (Biennial), New York Coliseum, New York, N. Y.

June 5–7, 1962
ASME Fuels Symposium, Rutgers University, New Brunswick, N. J.

June 10–14, 1962
ASME Summer Annual Meeting, Chateau Frontenac, Quebec, Canada

(For Meetings of Other Societies, see page 114.)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

Conducted for the National Junior Committee

JUNIOR FORUM

J.W. FOLLANSBEE[1]

Who Makes a Good Manager?

One of the many questions young engineers ask prospective employers is "What are the chances of working up into management? What is my future with your company?" The reverse question is also asked by the companies, "Will this man make a good manager or executive?" I cannot deal here with all the facets involved in these questions, but I can touch on one aspect I came across recently. It indicates that some men will make extremely good engineers but terrible managers. The comments are based on a talk given last year by Dr. Johnson O'Connor of the Johnson O'Connor Research Foundation.

One of the most important aptitudes that affect the engineer-manager question is personality. It, and the 18 other aptitudes found by the foundation, is a genetic trait and, along with the others, is subject to genetic laws. The trait is divided into two types: objective and subjective. The first, more commonly known as the extrovert, is genetically dominant (found in three quarters of the subjects tested) and is best suited for the managerial role. The second (introvert) is recessive and allies closer to the engineers' role.

As indicated in the afore-mentioned, though, personality is only one of many aptitudes that can be found in a given person. Other aptitudes include abstract and structural visualization, manual dexterity, tonal memory. All these genetic traits are independent of each other and follow the laws of simple probability so far as the possibility of finding any one or combination of any in that given person. So it is just as rare to find someone with only three appitudes as it is to find someone with sixteen.

Most people have between five and fourteen aptitudes and in that fact lies one of the unexpected findings of the foundation. In the past it was assumed anyone could do the type of routine work requiring only one or two aptitudes. This is false. The main reason for job failure proves to be a frustration born of the fact that too few aptitudes or abilities are called for by the job rather than too many. In other words, the worker is simply bored. Very few persons have only one or two aptitudes.

Going further, if the number of persons who have only two abilities is few, the number who have two specific aptitudes is much rarer. Yet this is what Dr. Johnson suggests using for the perfect executive. This executive should have an objective personality and have an extensive vocabulary. Period. Possession of any other aptitude will tend to subtract from an executive's efficiency. The reason is simple. If the manager has an aptitude in a given area he will tend to succumb to an urge to do the job himself rather than to delegate it.

Converse to the description of a manager, the engineer lies in the other end of the aptitude scale. Most engineers are subjective in personality and possess more than the average number of aptitudes. For these reasons, subjective engineers with many aptitudes who are promoted to management are often both unhappy and unsuccessful. The many-faceted person usually can make a success out of almost any job he tries, but the success is often short lived. It is also seldom accompanied with any natural satisfaction of doing a job about which you have a natural leaning. Dr. O'Connor gives as the three requirements for success as: (*a*) Having the right combination of aptitudes for a given job; (*b*) having acquired skill resulting from practice at the job; and (*c*) having an English vocabulary—or knowledge. Most engineers rank low in vocabulary and stand the chance of lacking requirements one and two after promotion into a new job.

Unfortunately, there is no simple means of finding one's personality traits. Tests are not perfect nor are formulas. Yet, although many engineers are not the subjective type with many aptitudes, the chances of going in the right direction; namely, of going up in engineering or in management, are better if you can get some idea of where you fit in this picture.

[1] Designer, Voorhees, Walker, Smith, Smith & Haines, New York, N. Y. Assoc. Mem. ASME.

ACTIONS ASME EXECUTIVE COMMITTEE

A meeting of the Executive Committee of the Council was held in the rooms of the Society on Friday, April 14, 1961. There were present: W. H. Byrne, President; H. N. Muller, L. N. Rowley, and R. B. Smith of the Executive Committee; E. J. Schwanhausser, Finance Committee Chairman; C. E. Davies, Secretary-Emeritus; O. B. Schier, II, Secretary; W. H. Larkin, W. E. Letroadec, and J. D Wilding, Assistant Secretaries; H. I. Nagorsky, Controller; and J. T. Reid, Research Manager.

Council Policy. ***Custodian Funds.*** The Research Executive Committee and the Board on Technology recommended a rewording of Council Policy P-4.1, "Policy on Custodian Funds," to require two signatures on all withdrawals from research custodian funds. The Council voted to reword Paragraph 8 of the Policy to read as follows: ". . . except for research committees when the signature of one authorized member and the Society's Research Manager shall be required."

Professional Divisions. ***Underwater Technology Group.*** The Council authorized the formation of an Underwater Technology Group whose scope will be the study of underwater shock, drilling, vehicles, transportation and propulsion, and oceanographic equipment, and which will be assigned to the General Engineering Department under the Board on Technology. (Mechanical Engineering, May, 1961, p. 139.)

Research Executive Committee. ***Research Committee on Properties of Steam.*** In 1954 the Council accepted the secretariat for the International Conferences on Properties of Steam (ICPS) and requested the ASME Research Committee on Properties of Steam to assume such secretariat duties. Expenses incurred during the past six years have totaled $22,164.30 and have been paid from the G-84 fund. On recommendation of the

How Well Do You Know Your Society?

So that the members of ASME may know their Society, attention is called to the list of Manuals and Annuals available upon request from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Unless otherwise noted, all the items in the list will be sent without charge.

AC 2	Annual Report of ASME Research
AC 10	Personnel of Council, Boards, and Committees
AM 1	Membership List—Alphabetical and Geographical Biennial—odd-numbered years)
AM 3	Catalog of Publications (also included in "Mechanical Catalog")
AM 4	Members List—Listed by Companies (Biennial—even-numbered years, $2 each)
AM 5	Indexes to ASME Papers and Publications
MM 1	Certificate of Incorporation, Constitution, By-Laws, and Rules
MM 2	Know Your Society
MS 4	An ASME Paper (50 cents to nonmembers)
MS 61	Citizenship and Participation in Public Affairs

Secretary, the Council authorized the transfer of this sum from the Research Operating Reserve (G-53) to the Research Committee on Properties of Steam (G-84).

Supplement No. 2 to Research Agreement 95-1. The Secretary signed Supplement No. 2 to Research Agreement 95-1 with M.I.T. extending the expiration date from Jan. 31, 1961, to Sept. 30, 1961, and increasing the maximum to be paid from $10,000 to $14,000 for work sponsored by the Research Committee on Random Vibration for which sufficient funds exist in the Committee's custodian fund.

Sections. ***Los Alamos Group of the New Mexico Section.*** The Council authorized the formation of the Los Alamos Group of the New Mexico Section with headquarters at Los Alamos and the territory to be constituted of the following New Mexico counties: Los Alamos, Sandoval, Sante Fe, and Rio Arriba.

Calvin Rice Lecture. ***1961 Lecturer.*** Prof. O. A. Saunders, I. Mech E. president, in response to the Society's invitation, will present the Calvin Rice Lecture at the International Heat Transfer Conference on Wednesday, Aug. 30, 1961, in Boulder, Colo.

European Trip by Editor. ***Inspection of Volkswagen Plants.*** Volkswagen of America, Inc., had invited editors of leading engineering, business, industrial, electronics, and utilities magazines in the United States to visit the Volkswagen plants in Germany on an expense-paid trip departing April 19, 1961, and returning on April 26, 1961. The Council authorized J. J. Jaklitsch, Jr., Editor, ASME, to participate in the trip to Germany.

ASME Organization Study. ***Cresap, McCormick, and Paget Report.*** The Executive Committee of the Council voted: (*a*) To receive the report on the "Study of Membership and Services in a Changing Technology," prepared by Cresap, McCormick, and Paget; (*b*) to instruct the Secretary to write to Cresap, McCormick, and Paget to determine what further fees and charges would be forthcoming, if any, and to advise them that the Council desires the balance of the 50 copies of the report requested in the Secretary's letter to them, dated Feb. 16, 1961; and (*c*) to send complete copies of the report to the entire Council, Organization Committee, and the chairman of the Boards on Technology, Codes and Standards, Membership, and Education, and to the chairman of the Finance Committee after copies become available.

Unity of the Profession. ***Report.*** R. B. Smith, Chairman of the ASME Intersociety Relations Committee, gave a verbal progress report regarding developments and indicated that he hoped to have a full report for the Council in June. The Council voted: (*a*) To endorse the proposed course of action to be taken by the ASME Intersociety Relations Committee; and (*b*) to instruct the ASME Representatives to oppose actively the amalgamation of ECPD and EJC.

Certificates of Award. ***Retired Committee Chairmen.*** Certificates of Award have been prepared for the following: J. C. Marshall, Engineers Registration Committee, 1960; J. C. Thompson, Civic Affairs Committee, 1959 and 1960; and R. M. Watson, National Committee of ME Department Heads, 1960.

Power Test Codes Committee Chairman. The Council authorized the preparation of a certificate of award for Rawleigh M. Johnson who served as chairman of the ASME Power Test Codes Committee from 1955 to 1960.

Retired Section Chairmen. Certificates of award have been prepared for the following 1959–1960 Section chairmen: S. E. Weidler, Hudson-Mohawk; R. B. Campbell, Inland Empire; N. H. Eckler, Pittsburgh; J. H. Colby, South Texas; E. B. Koelliker, Gulf Coast Subsection; and C. H. Robbins, Santa Clara Valley Subsection.

Section Member Gifts Chairman. On recommendation of Vice-President Muller, Region V, the Council authorized the preparation of a certificate of award for John Raymond Lowe, Jr., Member Gifts Chairman of the Cleveland Section, for his efforts to reach 100 per cent of quota for the Section.

Appointments. ***Presidential.*** A. M. Perrin, Chairman, Advisory Committee to President Byrne.

H. F. Roemmele, April 24, 1961, Inauguration of the First Chancellor of the City University of New York.

Vice Presidential. T. S. Fetter, Jr., and J. T. Evans, annual meeting of The American Academy of Political and Social Science, April 14–15, 1961, in Philadelphia, Pa.

ASME Members Have High-Limit Accident Insurance Plan Added to Their Group Insurance Program

A NEW plan of high-limit accident insurance covering death, dismemberment, and permanent total disability was recently approved by the Council as an addition to the Group Insurance Program for Members of ASME. This new plan became effective April 15, 1961. It offers coverage to a maximum of $200,000 at an annual cost of 90 cents per $1000 for members under 70. (Only $5000 accidental death or dismemberment coverage is available now through the Loss of Time Plan.)

The new plan covers accidents around the clock, including accidents at home, at work, and on vacation, and is not confined merely to travel. There are no health requirements for coverage of $100,000 or less.

Coverage is written by the American Casualty Company which underwrites the other plans in the Program. The new protection is offered at much lower cost and with broader coverage than individual policies. For example, the cost of accidental death and dismemberment coverage under an individual American Casualty policy is a minimum of $1.65 per $1000 with premium increases after age 60, as compared to 90 cents per

thousand under the new plan for ASME members under age 70. The new plan also provides for payment in case of total and permanent disability due to an accident. This coverage is not provided for in the individual American Casualty policy.

Material describing the new coverage has been mailed to ASME members. Duplicate material can be obtained from The Administrator, Group Insurance Program for ASME Members, 1120 Connecticut Avenue, N.W., Suite 920, Washington 6, D. C.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee. Upon receipt of your application a copy of our placement-fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

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Men Available

Chicago Office

Management Engineer, BSME; 40; 14 years sales, application, and market planning of heating, ventilating, and air-conditioning equipment. Experience in power plant and industrial air requirements for steam generators and manufacturing processes. $10,000, plus. Prefers Midwest. Me-2179-Chicago.

Export Management or Consultant, two years ME, Armour Institute; registered PE, Ill. 65; 12 years in importation of mechanical products in Europe; 22 years in export of heavy construction machinery to all parts of the world. Expert in foreign sales promotion of heavy machinery. Prefers Chicago, Ill., area. Me-2180-Chicago.

Chief Engineer, MSME; 32; registered engineer; 12 years' experience in mechanical engineering; first five years in machine-tool field; last seven years in industrial truck-transmission engineering and as assistant chief engineer on earthmoving equipment. Also part-time instructor in machine design for five years. Proved supervisory ability and leadership. $11,000–$13,000. Location optional. Me-2181-Chicago.

Sales Engineer, in training, BSME, Purdue, 1959; 25; past experience in maintenance and plant engineering includes cost estimation, proposal presentation, and co-ordination of actual installation effort. About $6800. Prefers Chicago area. Me-2182-Chicago.

Industrial-Management Engineer, BSIE plus graduate work; 28; IE and cost experience in division of integrated heavy industry corporation, prefers aggressive company with production or organization problems. Ability to analyze, solve, sell, and follow-up work to insure above average performance. Capacity to originate and supervise operations. $9000. Midwest. Me-2183-Chicago.

Instructor, BSME; 26; three years' experience mechanical engineering, machine-design section of plant engineering, steel company. Desires to enter teaching field. Open. South, other locations considered. Me-2184-Chicago.

Project Engineer or Administrative Engineer, BME, MBA; 30; experienced in design and development of hydraulic and pneumatic controls. Supervisor of development and test laboratory. Administrator of product design and development programs. $700–$800 a month depending upon location. Southwest, South, Midwest. Me-2185-Chicago.

Engineer, BSME; 34; field supervisor with electrical equipment manufacturer for five years; two years project engineer supervising maintenance and construction with scheduling and cost control; then buyer with same employer for one year in charge of all purchasing. Location immaterial. Me-2186-Chicago.

Executive Assistant, BSME, BSIE; 39; 11 years' experience with reputable management consultants in industrial engineering and cost accounting. $12,000–$15,000. Midwest. Me-2187-Chicago.

Works Manager, Plant Manager, Manager, Manufacturing Engineering, BSME, Univ. of Michigan; 37; broad experience in product and manufacturing methods in volume and job-shop production of metal-fabricated parts. Direct experience in most phases of manufacturing organization. Profit-making appreciation for control of costs, organization, and standardization of functions and routines. $18,000. East, Midwest, West. Me-2188-Chicago.

Industrial Engineer, Manufacturing or Production, BSME; 23; experienced in design of plant services, such as plumbing, heating, ventilation, materials handling, since graduation. $5500. Mich., Calif. Me-2189-Chicago.

Mechanical Engineer; 38; 18 years' experience solving operational, construction, and design problems. Have strong ability in spatial thinking, mechanical comprehension, and business procedures. Desires challenging nonroutine employment with small progressive organization. $8000. Chicago, Ill. Me-2190-Chicago.

New York Office

Heat-Treating Superintendent or Engineer, BME (Metallurgical option); eight years' experience purchasing, installation, and operation of high-volume ferrous manufacturing, heat-treat including annealing, controlled carburizing, hardening, press quenching, and personnel supervision. Prefers East or South. Me-947.

Sales Manager, currently district sales and marketing manager; 14 years' experience in equipment sales to power stations, utilities, large building construction, mechanical trades, or industrial accounts. Experience in both direct and resale (distributor or O.E.M.) sales. Looking for a smaller company that wants to advance with leadership as sales/marketing manager. Me-948.

Sales Engineer, BME, Rensselaer; 40; 14 years' railroad supply experience in sales, service, application engineering Northeast and Canada; also sales supervision. Desires sales opening in that field, allied industries, or heavy machinery. $10,000. New York area. Me-949.

Senior Engineer or Project Manager, BS(ME); 20 years' diversified experience in precision mechanisms with 12 years as supervisor of aircraft-instrument design and development including production, performance, and testing of prototypes following through production engineering and quality control. $12,000. Prefers metropolitan New York. Me-950.

Junior Electromechanical Engineer, BME, NYU, 1961; 1½ years' experience military electronics, aircraft radio, and navigation; 2 years' cumulative experience as engineering aid, rectifier application, and specification writing. $6700. Northern N. J., Long Island, N. Y., or southern Conn. Me-951.

Design and Development Engineer, BSME; four years' experience international field consulting on major appliance-engineering problems, including one year overseas assignment where responsible for design of refrigerator and training of local personnel; two years' experience electronic heat-transfer equipment. $9000. Location immaterial. Me-952.

Marketing Manager or Purchasing Agent, ME, 1947; MBA, 1949; three years' experience as textile foreman in weaving and finishing; four years' textile sales to retail and institutional users; four years' chemical industry as sales representative selling inorganic chemical raw materials to basic industries. $15,000. Location immaterial. Me-953.

Mechanical Engineer, BSME, Purdue 1947; central station steam-plant engineering, equipment selection, heat balances, flow diagrams, system descriptions, submarine propulsion and auxiliary systems, and nuclear systems engineering. $10,000. New York, N. Y. Me-954.

Mechanical Engineer, BME, MS; Six years' experience as equipment engineer for both large and small manufacturing operations. Design and development of equipment used for production purposes. Co-ordination and supervision in the building, installation, and testing of equipment. $9000. East. Me-955.

Plant Engineer or Executive, ME, Stevens; plant engineering and management with major oil company and smaller companies including procurement, design, specifications, constriction, start-up, trouble shooting, maintenance, repair, supervision, and administration including organization, salary administration, labor relations, training, safety, and selection of personnel. $8000, plus. Prefers metropolitan New York. Me-556.

San Francisco Office

Plant Engineer, ME; 36; ten years' varied plant engineering, layout, construction, building maintenance, plant utilities, machinery layout, cost estimates, specification writing, purchasing practices. Prefers Southwest, Far West. Home: Md. Se-1427.

Research, Development Engineer, IE; 34; over seven years' experience in mechanical-component qualification, evaluation, environmental testing hydraulics, pneumatics, hydrostatics, reliability testing, and design. Prefers San Francisco Bay area. Home: Calif. Se-1417.

Salesman, ME; 44; sales experience in aluminum, cutting tools, industrial-process controls. Prefers Bay area or West Coast. Home: Conn. $12,000. Se-1451.

Plant, Industrial, Maintenance Engineer, IE; 37; 12 years' experience in administration, supervision, and co-ordination of multimillion building and facilities projects from start to finish including design of process piping, heating, ventilating, installation of tools and equipment, and plant layout. $9000. Prefers Calif. Home: Mich. Se-1641

Designer, Draftsman, ME; 29; recent graduate, over a year's experience designing and drafting small parts of machines such as pressure vessels. $500 a month. Prefers San Francisco. Home: Calif. Se-1646.

Designer, Research Engineer, ME; 40; 14 years' experience in research, development, and design of internal-combustion engines (structure development to withstand shock vibration, de-

[1] All men listed hold some form of ASME membership.

sign studies of various engines); six years' machine-shop experience building tool and die fixtures. $12,200. Prefers western U. S. Home: Mich. Se-1597.

Sales Engineer, ME; 47; nine years' sales experience in machine tools, bearings, gears, electric motors, air conditioning, furnaces, water heaters, tools and dies, and diesel engines. $600 a month. Prefers northern Calif. Home: Calif. Se-1539.

Chief Designer, ME; 35; 15 years' experience in advanced work on mechanisms and structures involving stress, mechanisms, control, and power fields. $12,000–$15,000. Prefers northern Calif. Home: Calif. Se-1647.

Sales, Design, Estimating Engineer, ME; 46; over five years' experience in design drafting, supervision, estimating, and sales of heating, ventilating, plumbing, piping, and air-conditioning systems. $600 a month. Prefers Pacific Coast. Home: Calif. Se-1460.

Specifications and Report Writer, mechanical background; 54; 6 years specifications and reports, general construction, military installations, and hydroelectric, irrigation projects. One year reports-proposals electronic R&D; 3 years writing O&M manuals. Formerly architectural engineer, Captain Corps of Engineers, certificate as associate specifications writer. $650–$850 a month. Prefers San Francisco Bay area. Home: Calif. Se-686.

Production Engineer, ME; 47; diversified experience in production, planning, staff engineering in heavy and light industry, also purchasing and sales. $750 a month. Prefers West Coast or foreign. Home: Calif. Se-1552.

Plant, Production Manager, ME; 51; 13 years' experience including supervision of production and scheduling machine design and plant layout, engineering liaison with customers, technical assistant to shops and estimators; two years interpreted specifications, technical assistance; three years planning, scheduling production, analyzed sales trends, co-ordinated multiplant operations; five years' production development, construction, and testing of prototype models, analyzed test results. $800 a month up. Prefers San Francisco Bay area. Home: Calif. Se-1709.

Positions Available

Chicago Office

Steam-Power-Plant Designer, graduate mechanical, minimum of five years' experience in design of steam-power plants and experience in supervising personnel. All work will be in the office of a consultant. $8400–$10,000, depending upon experience. Employer pays fee. Iowa. C-8652.

Plant Engineers, graduate mechanical, electrical, chemical, or civil, to 40, with at least six years' experience covering installation, operation, and maintenance of equipment, buildings, and facilities, including pumps, compressors, material-handling equipment, driers, piping, refrigeration equipment. At least two years' experience in supervision of staff position. Will prepare sketches and lay out drawings for new or replacement of equipment, buildings and facilities, select proper sizing of equipment, design control system for automatic or safety operation of equipment; prepare report analyses and equipment specifications. Develop prescribed economical methods and materials for maintenance of equipment, buildings, and facilities. Good writing ability. 25 to 30 per cent travel for a processor of food products. About $9500. Company will negotiate fee. Chicago, Ill. C-8629.

Industrial Engineers, graduate mechanical or industrial, to 43; with none to five years' experience in general industrial engineering, i.e., methods, time study, costs, etc. Will work in the field on methods, time studies, cost reduction, etc., within a 40-mile radius of Chicago, for a railroad; home every night; car required. Can use recent graduate and train. Must be U. S. citizen. To $12,000, depending upon experience, plus expenses for car and travel. Company will pay fee. Chicago, Ill. C-8627.

New York Office

Sales Engineer, degree in mechanical or electrical engineering, at least five years' experience in the hot metal-forming business. Sales and engineering background highly desirable. Will be responsible for making contacts in the hot metal-forming business for the purpose of studying and evaluating methods and techniques used to heat billets for hot forming, shaping, and heat-treating and ultimately recommending utilization of company's equipment to accomplish operation more efficiently. $10,000–$12,000. Company pays fee. Ill. W-334.

Marketing Manager, five to ten years' experience in an organized market-research department and/or product management. Experience with a company making products sold to industrial users as well as through distributors preferred. Experience in advertising and sales promotion is necessary. $10,000–$12,000. Company pays fees. Mich. W-333(*b*).

Engineers. (*a*) Industrial engineer, headquarters staff, graduate mechanical or industrial, with none to two years' experience, for work covering a wide range of industrial-engineering activities. First year would be spent primarily in training and orientation and would involve considerable travel. To $7200. Northern N. J. (*b*) Industrial engineer, graduate mechanical or industrial preferred, with none to two years' experience; practical foundry background helpful. Position will involve responsibilities covering a wide range of industrial-engineering activities in a division with four plants producing copper alloy castings, bearings, steel mill copper products. To $6900. Company pays fees. Pa. W-332.

Mechanical Engineer to design on tools, jigs, and fixtures and some production equipment in a semiconductor manufacturing operation. Will supervise draftsmen and tool designers. Must have had three to five years' experience in design of electromechanical equipment. $8000–$9000. Northern N. J. W-331.

Quality-Control Manager, engineering degree desirable, two to five years' experience in a supervisory or semisupervisory capacity directing or administering a quality-control program and procedures in an insulated wire and cable manufacturing organization. Will report to plant manager; supervise 12 to 15 inspectors and technicians; be responsible for all phases of inspection; electrical and physical testing; incoming materials, in-process, and final inspection; government specs and use S.Q.C. procedures. $8000–$9000. Conn. W-330.

Mechanical Engineer, graduate, two to three years' experience in the design modification or programming of automatic machine tools. A knowledge of mechanical engineering and machine-design principles; imagination, initiative, and resourcefulness. S. C. W-325.

Industrial-Sales Engineer, graduate mechanical, chemical, or industrial, 25–32, one to two years' experience, to sell original equipment manufacturers, process industries, contractors, distributors, and selected industrial firms a complete line of company products on a noninstalled basis. $6300–$7200, plus complete fringe benefits and profit-sharing program. Arrangements regarding car. Initial training in New York, N. Y. W-324.

Marketing-Product Engineer, graduate, under 40, staff-research product market; to make financial projections, introduce new lines in connection with hydraulic equipment in the industrial-product market, i.e., pumps, cylinders, valves, etc. $12,000–$15,000. Midwest. W-321.

Assistant Chief Engineer, graduate mechanical, with five to ten years' experience in heavy industry, preferably supervising product development for large tube mill. About $10,000. Northern N. J. W-317.

General Supervisor, graduate, for the operation and maintenance of a salt and gypsum quarry, to supervise all maintenance with native help, including power plant, several diesel electric locomotives, and harbor installations for shipping. Spanish absolutely necessary. Company supplies car and housing. $12,000–$15,000. Dominican Republic. F-302.

Mechanical-Equipment-Specifications Engineer, 24–30, graduate and/or professional engineer, three to ten years' experience, qualified to select and specify mechanical equipment, i.e., pumps, compressors, turbines, material-handling equipment, etc., peculiar to the chemical, petrochemical, or refinery industries. Midwest. W-293(*b*).

Project Engineers. (*a*) Area engineer, BS in textile or mechanical engineering, one to five years' experience, for sewing and related mechanical operations. Will be responsible for design and installation of tools, jigs, fixtures, dies, and other cutting and packaging operations. To $8000. (*b*) Process engineer, BS in mechanical or chemical engineering, one to five years' experience in process or allied industries. Will be responsible for the development and installation of improved processes and improved chemical and mechanical equipment; for process control, specifications, and technical and engineering service. To $8000. Company pays fees and relocation expenses. East. W-275.

Product-Design Engineer, graduate mechanical, proved ability to conceive and carry out design of electromechanical equipment such as fractional hp fans and blowers, small power tools, light home appliances, etc.; experience in design of light air-moving equipment; proved creativity in producing new and improved designs essential; knowledge of manufacturing processes to insure low-cost producibility of designs. Will conceive and carry out design of variety of small, high-performance electromechanical devices, many requiring application of fractional hp motors, for both industrial and military applications. Salary plus fringe benefits and profit-sharing. Hudson Valley, N. Y., area. W-271.

Industrial Engineer, graduate mechanical or industrial, 25–40, for industrial-engineering consultants in the field of materials handling, conveyers, warehousing, plant layout, etc., 25 per cent travel; home each week-end. $10,000–$12,000. Headquarters, New York, N. Y. W-268.

Industrial Engineer, graduate industrial or mechanical, for consulting-engineering firm, on methods, space and facilities planning and layout, and reports. Some travel, mostly local. $9000–$10,000, plus extra $25–$30 per week for out-of-town assignment. Headquarters, New York, N. Y. W-264.

Engineers. (*a*) Tool design and methods supervisor, graduate industrial or mechanical engineer, experience in tool design and tooling of capital equipment. Experience co-ordinating product design and tool-design work; experience with general methods of heavy machining. Should be able to take a fresh approach to drawing room methods; also standardization and indexing of tools and jigs. (*b*) Manufacturing engineer, graduate industrial or mechanical, ten years' in heavy machine-shop work, to maintain liaison with tool design and methods department, foundry, product engineering, and final assembly and test to solve day-to-day problems. Should be a good machine-shop trouble shooter. Some experience with method and cost reduction. (*c*) Production management and control engineer, experience in scheduling production and managing a production-control system. Experience with inventory and production records and machine loading in heavy machine shop or jobbing operation required. Experience with use of business machines for data collection and production control desirable. N. Y. State. W-257.

Design Engineers. (*a*) Engine designer, graduate mechanical, with ten years' experience in the design of internal-combustion engines, preferably the larger diesel and natural gas engines. Should have layout experience with general engine work and components and be familiar with torsional vibration balancing and stress analysis. (*b*) Portable compressor design engineer, graduate mechanical, ten years' experience including layout and design work on portable compressors or similar products. Experience with rotary compressors, gasoline and diesel engines, cooling systems, and running gear desirable. (*c*) Rotary compressor engine, graduate mechanical, experience in engineering and design connected with high-speed rotating machinery such as centrifugal or positive displacement rotary compressors. Experience in layout and design calculations with these products desirable. N. Y. State. W-256.

Sales Engineer, mechanical graduate, at least five years' field sales experience covering pneumatic and hydraulic cylinders, valves, and control mechanisms. New York Metropolitan area. W-250.

San Francisco Office

Power-Plant Engineer, 35–55, graduate mechanical or electrical, qualified to handle client contact, develop new business, do engineering, supervise design. Thoroughly informed concerning thermal steam-power plants, gas, oil, coal. For a consultant-engineer builder. Submit past record of successful accomplishments. $15,000–$20,000. Headquarters, San Francisco Bay area. Sj-6084.

Project Engineer, graduate mechanical or chemical, to 50, ten to 15 years' project experience. Familiar with mechanical work and equipment-type plant. Work on refinery and chemical-process plants, manage project. Customer contact, responsible for project from start to finish. No field work. For a consultant. $9000–$12,000. San Francisco, Calif. Sj-6124.

Chief Engineer, Production Superintendent, mechanical manufacturing background, 40–55, ten to 15 years' experience in medium-sized metal-working job shop on castings, heavy rod and tubes, cylinders. Completely informed on research, engineering, manufacture, and job-shop production. Able to handle 75 to 100 men on machinery, grinding, boring, turning, drilling, plating, welding, finishing, assembly and shipping, close tolerance precision large equipment. $8000–$10,000, plus. Mendecino County, Calif. Sj-6101.

Industrial Engineer, graduate industrial or mechanical, 25–37, minimum of two years' experience working on cost reduction, plant layout, some time and motion preferably for a food-processing plant (raw to finished staples product, canning, label, package, transport, convey, warehouse). For a national manufacturer. About $600. Santa Clara County, Calif. Sj-6081.

Inspector, graduate mechanical, minimum of five years' experience, to inspect mechanical aspects of heating, piping, ventilating, air conditioning, water lines on new construction project. Job will last about two years. $800 a month. Calif. Sj-6072.

Management Trainee, graduate mechanical, to 30, no experience required. Two-year training program, one to six weeks' work in every department of company. After training, assignment to one department as assistant manager. Prefer experience in machinery operation, tool machinist. Customer contact. Should be willing to relocate (plants throughout the U. S.; prefer West Coast resident). From $500 a month to start. San Francisco, Calif. Sj-6065.

Mechanical, Industrial Trainee, recent graduate industrial, with mechanical background, able to do drafting. Liaison between superintendent of plant and plant manager. Later in charge of lab testing windows and doors, machinery in production line. Report to plant manager. For a manufacturer of light metal doors and windows. Salary commensurate with experience. San Francisco area. Sj-6043.

Promotional Engineer, from 50, semi-retired preferred, experience with refrigeration, take-off, plumbing, heating. Will deal with architects, associations, contractors, city officials. Protect codes, bids on piping, keep standards up. $8000. Ariz. Sj-6037.

Plant Engineer, minimum of ten years' experience, to supervise and direct general plant and equipment maintenance and construction. For a wood-treatment company. Sj-6118.

Sales Manager, Application Engineer, to 50, mechanical graduate or equivalent, application and sales experience in sewage disposals, sewage-lift stations, installations, for development and design. Foreign assignment to manufacturing branch or U. S. with travel in foreign countries. For an international merchant and shipping agent. About $800 a month. San Francisco, Chicago, and foreign. Sj-6115.

Sales Manager, 25–32, mechanical background, two to four years' sales experience. Train in San Francisco six to 24 months, then foreign office, primarily Asia. Correspondence, supply, pricing, customer quotation, sources of supply for wide variety of machinery and equipment for manufacturers, business, commercial, domestic use. Will deal with material to satisfy inquiries, orders, specifications. For an international merchant and shipping agent. Approximately $550 a month. San Francisco training, foreign location. Sj-6114.

Designer, Development Engineer, graduate mechanical, young, some to a great deal of design experience including some board work relating to small, precision machined, cast or formed metal parts, intricate linkages, interlocks, mountings and compact assemblies such as calculators, adding, or other office machines or related consumer goods. $600–$650 a month up. San Francisco East Bay. Sj-6097.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after June 26, 1961, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Promotions

Alabama

JEANE, JOSEPH A., Mobile
SASSER, MYRON J., Birmingham

California

BASHORE, JOSEPH E., Los Alamitos
●CROWLEY, CHARLES P., JR., Los Angeles
DAVEY, TREVOR B., Sacramento
DAVIS, WILLIAM R., Concord
EICHHORN, JOHN W., Marysville
GUNN, A. V., Pomona
LORCH, JAMES R., Oakland
MCKELLAR, LOUIS A., Menlo Park
TENOPYR, JOSEPH, San Pedro
WEINGARTEN, VICTOR I., Los Angeles
WESTERFELD, ROBERT C., Burbank
WILKISON, H. GENE, Solana Beach

Colorado

AMBLER EDWARD B., Denver
●ARNETT, ROBERT W., Boulder
●PORTZ, KENNETH L., Denver

Connecticut

BIRKELAND, PHILIP W., East Hartford
HAWORTH, RAYMOND F., New London
QUINLAND, JOHN J., Stamford
●TRINER, NEIL H., Middletown

Florida

ROACH, KENNETH C., Pensacola

Georgia

●DEHOFF, GERRY B., Atlanta

Hawaii

HONDA, GEORGE, Honolulu

Idaho

MONKS, JOSEPH G., Idaho Falls

Illinois

ALLMENDINGER, PAUL F., Chicago
GAVIN, RICHARD I., Northbrook
GEORGES, HEINZ A., Highland Park
●HALLINAN, JOHN C., Washington
HILLMAN, CHESTER E., Park Ridge
SCALET, WILLIAM J., Chicago
WALLIN, MAYNARD B., Chicago

Indiana

CRAWFORD, JAMES H., Indianapolis

Iowa

HANSON, CHARLES B., Newton

Louisiana

DAVIS, ROBERT L., Shreveport

Maryland

FELDMAN, LOUIS, Hyattsville
LANGAN, WILLIAM T., Baltimore
●RITTER, JOSEPH, Timonium

Massachusetts

ANDERSON, BRUCE W., Hudson
BARROWCLOUGH, HOWARD J., New Bedford
●KALFOPULOS, ATHANASIOS F., Roxbury
KAPINOS, JOHN, East Longmeadow
KLEMPERER, HANS, Belmont
PREMO, MARVIN C., Springfield
ROBINSON, JAMES A., Topsfield

Michigan

●ATKINSON, JOHN E., Jackson
HECHT, MORTIMER G., Grosse Ile
●HOLE, JOHN L., Lansing
SIECZKA, EDWARD, S., E. Detroit

Mississippi

WHITE, HAILEY B., Yazoo City

New Jersey

DOMENICHINI, ALDO, JR., Tenafly
●DUGAN, JOHN L., JR., New Brunswick
●FINKE, RICHARD A., Somerville
NIED, HERMAN A., Medford Lakes
RAKOWSKY, EDWARD L., Palisades Park
REE, JOHN F., Glen Rock
ROBERTS, GRANVILLE, Elizabeth
●SCHLIG, JOSEPH, North Caldwell
●WENDT, PETER G., Westfield

New Mexico

FULLER, CHARLES W., Los Alamos
●MALLONEE, RICHARD C., II, Las Cruces

New York

●BISSONNETTE, PAUL E., Ballston Lake
●BOUTROS, RICHARD D., Rochester
BURNS, HUGH, New York
DETTE, WALTER C., Corning
DREXEL, WERNER H., Jackson Heights
KHANNA, KAILASH C., New York
●KROEGER, CARROLL V., New York
LAHAYE, PAUL G., Ballston Lake
●LEWISON, ROBERT M., New York
MCKONE, THOMAS D., Schenectady
MURRAY, DONALD L., Schenectady
●REAGH, HARLEY P., JR., Camillus
●SCHEPER, GEORGE W., JR., Schenectady
SCOTT, JAMES D., Wellsville
●SILVER, EDWARD S., Brooklyn
WILDRICK, DEAN E., Cuba

Ohio

BILGIN, OZKAN, Akron
CAGNA, RICHARD J., Poland
●DELAMAIDE, JACK R., Hannibal
●EHRLER, ROBERT F., Lancaster
HOFFMAN, PAUL S., Alliance
MILLER, CHARLES E., Cambridge
OBERST, GLENN P., Helena
POWELL, WILLIAM C., JR., Cincinnati
●WOOD, RICHARD S., Alliance

Oklahoma

COUNCIL, BILL E., Ponca City

Pennsylvania

●EMSLIE, NORMAN M., Yardley
FITZSIMMONS, KENNETH W., Jeanette
HARRIS, RONALD L., Feasterville
KERSHAW, RICHARD F., Willow Grove
●KROMAYER, PETER H., Bethlehem
MENZ, PAUL G., Newton Square
●MILLER, CECIL E., Pittsburgh
●NEWTON, ALWIN B., York

South Carolina

●CHAUSSY, PERN J., Camden

Tennessee

BUS, MIKLOS A., Kingsport
DOMER, RONALD G., Oak Ridge
GRIMES, PATRICK M., Memphis

Texas

GRANTOM, CHARLES A., Houston
JANAK, JOHN D., Dallas
MINGES, GUS, JR., Beaumont

Utah

●THACKER, MILTON B., Salt Lake City

Virginia

CHRISTIAN, JOHN F., Fort Belvoir
NOLAN, JAMES M., Norfolk

Washington

●ADAMS, OTTO E., JR., Richland
BAKER, JAMES L., Kent
●BRYANT, STANLEY L., Seattle
●MCINTYRE, SIDNEY S., JR., Sedro Woolley

West Virginia

SMITH, JOHN C., South Charleston

Wisconsin

LORENZ, CLIFFORD H., Milwaukee

Foreign

BOWD, MICHAEL J., Montreal, Que., Canada
ESSAM, PETER, Slough, Bucks., England
GRAHAM, WILLIAM, Croydon, Surrey, England
HABIBULLAH, ABUL, H. M., Karlsruhe, W. Germany
KAZEK, RICHARD, Hamilton, Ont., Canada
KHAN, ABUL H., Manchester, England
PARISET, ERNEST F., Ville Lasalle, Que., Canada
SCOTT, DEREK H., La Oroya, Peru, S. A.
SHARMA, NAND L., Sundraghar, Orissa, India
SINGH, GULZAR, Amritsar, India
WHITTAKER, FREDERICK, G. R., Trinidad, W. I.

●Promotion to Member or Affiliate

OBITUARIES

William Henry Britt (1906–1961), engineering supervisor, Eastman Kodak Co., Rochester, N. Y., died, February, 1961, according to a notice received by the Society. Born, Hico, La., Jan. 21, 1906. Parents, John Allen and Frances Elizabeth (Rives) Britt. Education, BS(ME), Louisiana Polytechnic Institute, 1931. Married Anna Louise Liverman, 1934; children, Marjorie, James, and Katharine. Mr. Britt taught power-plant engineering at the Seneca Vocational School, Buffalo, N. Y., for several years after graduating, at the same time working as

an assistant chief engineer with the Buffalo Pumps, Inc., North Tonawanda, N. Y., where he was until 1941. From 1941 to 1949, he was research and development engineer with the Columbus McKinnon Chain Corp., Tonawanda, and its subsidiary, Chisholm Moore Hoist Corp. He had charge of welding and testing laboratories, product development, and quality control. During the war years, he returned to teaching part time and, from 1940 to 1945, trained more than 3000 persons as welders, machinists, and designers for the war industries, at the North Tonawanda Vocational School. To further this program, he obtained a grant of new machines and equipment worth $75,000 from the U. S. Government. From 1944 to 1949, he also was director, vice-president, and treasurer of the Tool Service Co., Inc., supervising its transition from a partnership to a corporation by establishing new systems of production planning, cost estimating, and accounting. He became chief engineer for The Columbia Mills, Inc., manufacturer of shades, screens, and industrial fabrics, in 1949, taking charge of special engineering for the company's four plants and 17 branches. As an author, he wrote operating instruction manuals for pumps used by the U. S. Navy, and rewrote the chapter on pumps for McGraw-Hill's "Paper Makers Handbook." He held patents on hoist and chain parts. Jun. ASME, 1936; Mem. ASME, 1954. He was director and vice-president of the New York State Junior Chamber of Commerce, 1939-1940. He was a member of the Buffalo Engineering Society, and was a registered professional engineer in New York State.

William Charles Bruckman (1910–1960), chief engineer, O'Keefe and Merritt Co., Los Angeles, Calif., died, April, 1960, according to a notice received recently by the Society. Born, Denver, Colo., March 30, 1910. Education, BS(ME), Antioch College, 1932. Mr. Bruckman specialized in the design, development, and manufacture of domestic electrical appliances. Before going with O'Keefe and Merritt, he was chief engineer with the Automatic Washer Co., Newton, Iowa, coming to that position after a period as a partner in New England Industries, Bradford, Vt. He was cofounder of that company, which manufactured small home appliances in addition to war products. Mr. Bruckman began his career with Westinghouse Electric Co., Mansfield, Ohio, in 1933, working first in the time-study department, and then moving into the tool-engineering and later the appliance-engineering departments. Then, after a period teaching production engineering at Antioch College, he became chief engineer at The Antioch Foundry, Delco-Remy and Allison Divisions, General Motors Corp., in Yellow Springs, Ohio. After three and a half years there, he joined Federal Telephone and Radio Corp., an associate of International Telephone and Telegraph, in Clifton, N. J. He became chief appliance engineer there, leaving in 1949 to help found New England Industries. He held a number of patents. Mem. ASME, 1952. He was a member of NSPE, an associate of AIEE, and a registered professional engineer in Ohio.

Wayne W. Glover (1906–1959), chief engineer, Simplex Valve and Meter Co., Lancaster, Pa., died, Dec. 11, 1959. Born, Camden, N. J., April 22, 1906. Education, high school, and evening courses at Drexel Institute of Technology. Mr. Glover joined the Simplex Valve and Meter Co. as a design draftsman in 1930, and worked continuously for the company. He became chief engineer in 1943 after periods as a junior engineer, a sales engineer, and an assistant chief engineer. As chief engineer, he supplied a special advisory service to customers concerning the application of company products to water works and waste-treatment plants. He authored an article on sewage meters for American City in 1942, and an article entitled "A Problem of Sewage Pump Operation Solved," published in *Water and Sewage Works*, 1944. Mem. ASME, 1951. He also was a member of the American Water Works Association, The Franklin Institute, and the Instrument Society of America.

Henry Edwin Haller (1879–1961), chairman of the board, National Valve and Mfg. Co., Pittsburgh, Pa., died, Feb. 13, 1961. Born, Pittsburgh, Jan. 13, 1879. Education, Iron City College. Mr. Haller was with the National Valve and Mfg. Co. since 1907, when he was its vice-president and general manager. He became president in 1912. He was experienced in power piping, and the fabrication and installation of piping materials. Mem. ASME, 1920.

Frederick (Derek) Harris-Lowe (1899-1961), manager of engineering, Ontario Paper Co., Ltd., Thorold, Ont., Canada, died, Hotel Dieu Hospital, St. Catharines, Ont., March 3, 1961. Born, Kent, England, April 7, 1899. Education, graduate, Kent College, Canterbury, England, 1917. As part of his education, Mr. Harris-Lowe spent some time doing field and office work in connection with the building of the Aylesford Paper Mills. The rest of his career, which was spent in Canada, was intermittently connected with paper manufacturing. He was a junior design engineer on building and plant layout with the International Pulp and Paper Co., Temiskaming, P. Q., from 1924 to 1926. Between then and 1937, when he was a design engineer with the Abitibi Pulp and Paper Co., Sault Ste. Marie, Ont., he worked on piping and construction projects with a number of companies, including Sutcliffe and Co., consulting engineers of New Liskeard, Ont.; the Ontario Foundation Co., Ltd., as a resident engineer on pier and bridge abutment design; and the Department of Northern Development, Ontario. From 1941 to 1945, he was an instructor and company commander in the Canadian Army, serving with the Royal Canadian Engineers, and in 1945, joined The Ontario Paper Co., Ltd. Mem. ASME, 1955. He was chairman of the ASME Hamilton-Niagara Subsection. He was a member of TAPPI, and the technical section of the Canadian Pulp and Paper Association. Surviving are his wife, Rosemary; a son, Derek; two brothers, Edward, Truro, N. S., and James; and a sister, Mrs. Jessie Thomas, England.

William Edward Hogan (1883–1961), engineer, City Plating Works, Inc., Bridgeport, Conn., died, St. Vincent's Hospital, Bridgeport, March 9, 1961. Born, Bridgeport, Jan. 16, 1883. Parents, William Henry and Martha Elizabeth (Carley) Hogan. Education, ME, Cornell Univ., 1906. Married Florence Dora Ingham, 1912. Mr. Hogan taught on the engineering faculty at Cornell until 1911, when he joined the University of Wisconsin faculty. During World War I, he left the academic life and joined Remington Arms, part of the Union Metallic Cartridge Co., then owners of the present General Electric site in Bridgeport. There he became a production engineer in charge of various contracts, but left the plant toward the end of the war to become a maintenance engineer with the DuPont Fabrikoid Co., Fairfield, Conn. In 1935, he joined the Works Progress Administration and for seven years served as a senior engineer in charge of all work in the State of Connecticut. Later, he became superviser of government inspectors for the U. S. Air Force at Sikorsky Helicopters, Bridgeport. After retiring at the age of 62 in 1945, he was asked to become associated with the City Plating Co., where he was manager of sales and advertising. Mem. ASME, 1943. The Fairfield County Section of ASME honored him in 1955 as its 75th Anniversary Medalist. He inaugurated the ASME Student Engineering Society at the University of Bridgeport and sponsored special technical courses there for ASME engineers. He was active in ASME committee work in the Fairfield County Section, where he twice held the offices of treasurer and chairman from 1944 to 1949. He served ten years as a member of its Executive Committee, and was a member of the executive committee of the National Spring Meeting in New London, in 1949. He was secretary of ASME Region I in 1950. He coauthored an article entitled "Industrial Hard Chromium Plating," published in MECHANICAL ENGINEERING in March, 1954. He also was a member of the American Ordnance Association, and was a registered professional engineer in Connecticut.

Walter Hamlin Kniskern (1880–1961), retired engineer, died, Petersburg Hospital, Petersburg, Va., Jan 30, 1961. Born, Sanford, N. Y., April 5, 1880. Parents, John Wesley and Mary Luella (Hamlin) Kniskern. Education, ME, Cornell Univ., 1904. Married Katharine Selden, 1907; one daughter, Katharine Kniskern Mather. A pioneer designer in the fields of high pressure and high temperature, Mr. Kniskern has been credited with a major role in developing the art of synthetic ammonia manufacture. After graduating from Cornell, he taught mechanical engineering at the University of Pennsylvania for a year, and then practiced engineering with several companies until 1912. Then he went to Spain for the Pearson Engineering Corp., New York, N. Y., to take charge of designing, constructing, and operating a San Antonio cement plant at the foot of the Pyrenees in Lerida, Spain. The cement produced there had the highest silica content of any made commercially. Mr. Kniskern returned to the U. S. A. in 1914, when he was employed by The J. G. White Engineering Corp., New York, to operate a cement plant at Portland Point, N. Y. In 1918, he became associated with the nitrogen operations of the Allied Chemical and Dye Corp., beginning a life-long association with that industry. He was chief engineer in charge of the design of the first commercially successful nitrogen fixation plant in the U. S. A., which was built in Syracuse, N. Y. Within Allied Chemical, he later became director of the Atmospheric Nitrogen Division, and then of The Solvay Process Division, in Hopewell, Va. He retired in 1948 after 30 years with the company. After retiring, he continued working and researching in a number of fields, including the design and assembly of high-fidelity music reproduction systems, the production of high-quality baked products, and geneological research. In the latter field, he authored a book "Some Descendents of Johann Peter Kniskern." He held numerous patents dealing with the manufacture of ammonia and its compounds. Assoc. Mem. ASME, 1905; Mem. ASME, 1912; Fellow ASME 1945. He was a member of SAE and ACS, and a registered professional engineer in New York State since 1923. He was a member of the scientific and engineering staff of the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. He is survived by his wife, Katharine, and daughter, Mrs. Bryant Mather, Jackson Miss.

Cuthbert Walter Roddam, Jr. (1922–1961), operations foreman, Refinery Division, Gulf Oil Corp., West Port Arthur, Texas, died, West Calcasieu-Cameron Hospital, Sulphur, La., Feb. 8, 1961. Born, Slagle, La., Dec. 17, 1922. Education, BS(ME), Louisiana Polytechnic Institute, 1952. Mr. Roddam was with Gulf Oil Corp. for nine years. In the First Marine Air Wing during World War II, he served three years in the Pacific theater. Assoc. Mem., 1952. Surviving are his wife, Rachel and two daughters, Kathy and Patricia, of Groves, Texas; his mother, Mrs. Ruby Roddam, Sulphur; his grandparents, Mr. and Mrs. W. W. Meek; two brothers, Doyle K. Roddam and Wayne Roddam; two sisters, Mrs. Charles Trahan and Mrs. V. R. Robinson, Sulphur; and a sister-in-law, Mrs. Carolina Roddam.

Milton Joseph Sirola (1920–1961), design engineer, Hanford Atomics Products Operation Div., General Electric Co., Richland, Wash., died, Feb. 5, 1961. Born, Aspen, Colo., March 1, 1920. Education, BS(ME), Univ. of Colorado, 1947. Mr. Sirola began working for General Electric in 1947 as a designer of tools and secondary structures. Since 1951, he had charge of engineering on process and service piping installations, and related mechanical equipment. He had previously been with the Douglas Aircraft Co., in El Segundo and Santa Monica, Calif., from 1943 to 1945; and before that was with Gardner-Denver Mfg. Co., Denver, Colo. Assoc. Mem. ASME, 1956. He also was a member of ASM. Surviving are his wife, Mary; one son, Byron; four daughters, Margaret, Barbara, Paula, and Linda; his mother, Mrs. John Sirola, Carbondale, Colo.; a brother, Lawrence, LaPuenta, Calif.; three sisters, Mrs. John Bono, Denver; Mrs. James Hovis, San Gabriel, Calif.; and Miss Alvina Sirola, Alhambra, Calif.

Robert J. Thoreson (1936–1960), mechanical engineer in the Plant Operations and Field Engineering Section, Directorate of Rocket Propulsion, Edwards Air Force Base, Calif., died, Nov. 18, 1960. Born, Portland, Ore., Feb. 25, 1936. Education, ME, Oregon State College 1958. Mr. Thoreson was with the Air Force at Edwards for two and one-half years. He was project engineer on the design and construction of the Combined Environmental Test Facility for testing missile system components of ballistic missiles such as the Atlas, Thor, Titan, and follow-on programs. He authored the paper "Facility Design for Combined Environmental Testing of Rocket Propulsion Components," presented at the ASME Aviation Conference in March. Assoc. Mem. ASME, 1958. He also was a member of ARS and the Edwards AFB Aero Club, and was a registered engineer-in-training in California. Surviving are his parents, Mr. and Mrs. C. O. Thoreson; two sisters, Sandra and Joanne, of Portland, Ore.; one brother, Richard, U. S. Navy; and grandparents, Mr. and Mrs. C. L. Winters, Wasco, Calif.

Franklin Edmond Washburn (1899–1960), district superintendent, Combustion Engineering, Inc., Philadelphia, Pa., died in 1960, according to a notice received recently by the Society. Born, Bangor, Me., Nov. 12, 1899. Parents, Ralph Cecil and Florence Edith (Russell) Washburn. Education, BS, Massachusetts Institute of Technology, 1926. Married Camille C. Egner, 1928. Mr. Washburn was with Combustion Engineering since 1926. He worked with the design, fabrication, erection, and operation of steam-generating and fuel-burning equipment. Assoc. Mem. ASME, 1924. Mem. ASME, 1935. He was a registered professional engineer in Pennsylvania.

Carl Frederick Weber (1902–1961), general foreman, Bausch and Lomb Optical Co., Rochester, N. Y., died, February, 1961, according to a notice received by the Society. Born, Geneva, N. Y., Feb. 28, 1902. Education, attended Rochester Institute of Technology and Tri-State College. Mr. Weber specialized in lens-processing machinery and equipment for processing ophthalmic frames. He began his career in 1919 with the Shuron Optical Co., Geneva, N. Y., where he did general drafting work. He left that company in 1925 and, after a short period with two other companies, American Can Co., Geneva, and the General Railway Signal Co., Rochester, he joined the research department of Bausch and Lomb. Thirteen years later, he was placed in charge of the Process Machine Design Div. He coauthored an article entitled "Lens Grinder," published in *Machine Design*. Mem. ASME, 1950. He was a member of the Rochester Engineering Society.

Terence Louis Whalen (1938–1960), process engineer, Lackawanna Plant, Bethlehem Steel Co., Buffalo, N. Y., died, Dec. 25, 1960. Born, Rochester, N. Y., June 11, 1938. Education, ME, Villanova Univ., 1960. Assoc. Mem. ASME, 1960.

YARWAY Y news briefs

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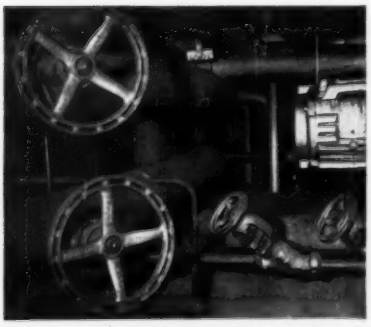
WHY YARWAY WELBONDS ARE SPECIFIED FOR HIGH PRESSURE VALVE JOBS

Yarway Welbond Valves (sizes ¼" through 2½") have won resounding acceptance from boiler room operators everywhere because of these 6 unique features—resulting in *outstanding performance* that is *dependable* and *trouble-free:*

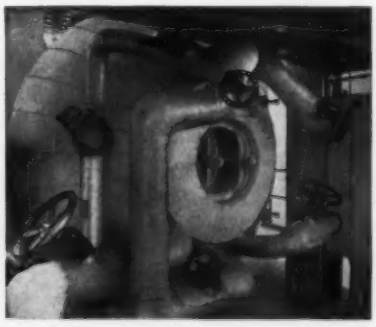
1. Full accessibility—all working parts readily removed through top of yoke. Jack action of stem forces out old packing.
2. Guided valve stem of #321 stainless steel—will not "pit." Self-aligning, stellite-faced disc.
3. High temperature inhibited stem packing furnishes double insurance against packing leaks.
4. Unique seat design with thermal compensating groove that prevents distortion during assembly welding and when welding valve into line. Also permits perfect seating of disc for tight seal. Integral seat is stellite-faced.
5. One-piece forged chrome-moly steel body and yoke.
6. Easy-grip, ventilated handwheel—makes operating a "breeze".

More details—and list of users? Write Yarway. Ask for Bulletin B-454.



Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.

Four Yarway Welbonds on main steam line to turbine at southern power plant. Press. 2310 psi; temp. 1000°F. Over 100 Welbonds here.



Six of 900 Yarway Welbonds at southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

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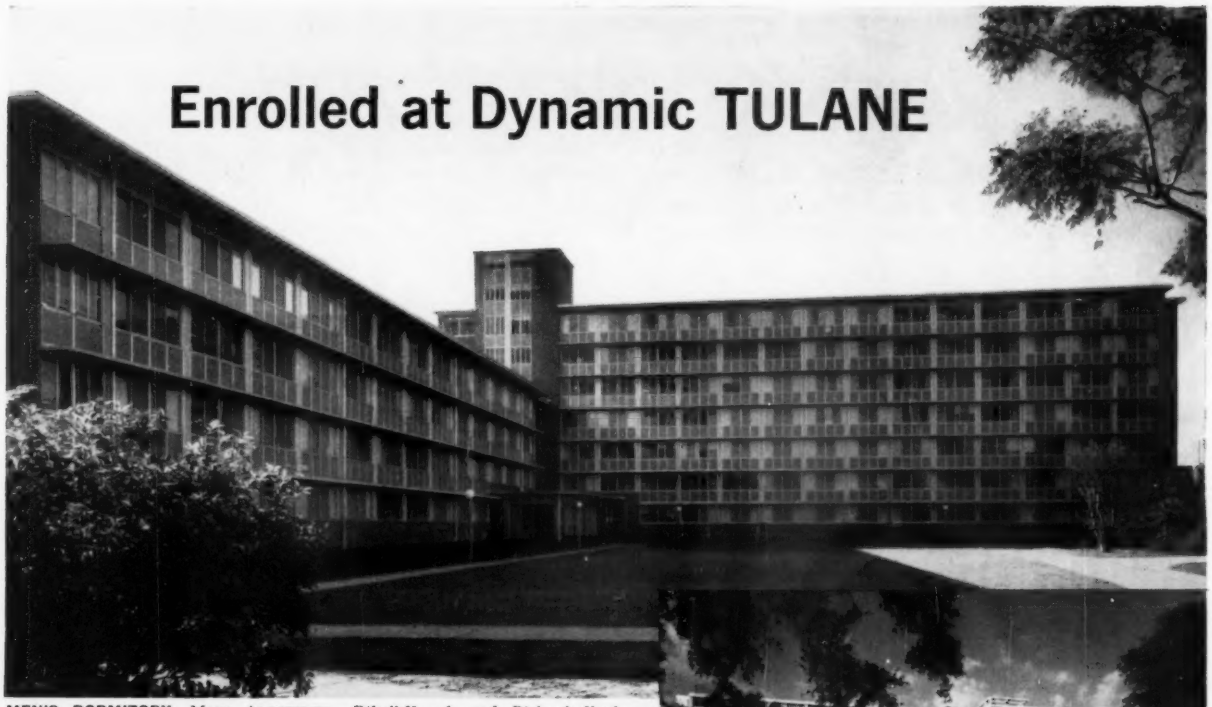
Enrolled at Dynamic TULANE



MEN'S DORMITORY. MAIN ARCHITECTS: *Diboll-Kessels and Richard Koch; S. Wilson, Jr. & Associates.* GENERAL CONTRACTOR: *Farnsworth & Chambers.* MECHANICAL CONTRACTOR: *Cabirac Mechanical Contractors, Inc.* CONSULTING ENGINEERS: *Jos. E. Leininger & Associates.*

APARTMENT BUILDING *for married students.* MAIN ARCHITECTS: *Goldstein, Parham & Labouisse.* GENERAL CONTRACTOR: *J. A. Jones Construction Co.* MECHANICAL CONTRACTOR: *Sciambra & Masino.* PLUMBING CONTRACTOR: *Jas. F. O'Neil Co., Inc.* CONSULTING ENGINEERS: *Design Engineers & Associates.*

JENKINS VALVES

for long-range dependability, long-time maintenance economy

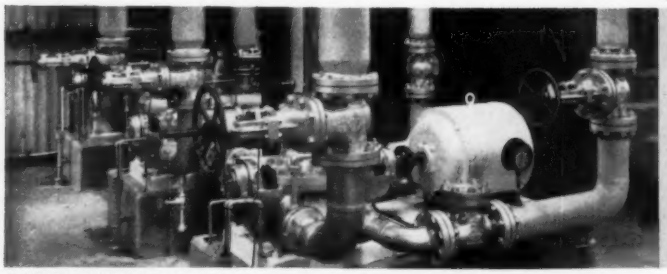
"Dynamic" is the word for tradition-laden, prestige-rich, 127-year-old Tulane University in New Orleans.

Nowhere is Tulane's dynamism more remarkable and articulate than in its current building program.* Examples: the three brand new, beautiful and beautifully functional structures pictured here.

If you toured these buildings and the power plant which serves the campus complex, again and again and again you'd see the distinctive Diamond-mark that identifies Jenkins Valves. And small wonder: a university which had its beginnings more than a century ago just naturally thinks in terms of long-range dependability, long-time maintenance economy . . . precisely the qualities which make Jenkins Valves the "Standard of Quality" by which other valves are measured! Yet — and this fact still comes as a pleasant surprise to some specifiers — *they cost no more!* Jenkins Bros., 100 Park Ave., New York 17.

*Tulane's supervisory and liaison personnel for the building program: Harold E. Pique, Director of Planning; George F. Johnson, Director of Physical Plant; Charles E. Gilbert, Utilities Superintendent.

UNIVERSITY CENTER *features swimming pool, bowling lanes, radio station, cafeteria, ballroom.* MAIN ARCHITECTS: *Curtis & Davis and Associates; Edward Silverstein.* GENERAL CONTRACTOR: *Farnsworth & Chambers.* MECHANICAL CONTRACTOR: *Sciambra & Masino.* CONSULTING ENGINEERS: *Leo S. Weil; Walter B. Moses.*



POWER PLANT. *Boiler feed water pumps and Jenkins Valves shown.* MAIN ARCHITECTS: *Paul Charbonnet, Jr.* GENERAL CONTRACTOR: *Gervais Favrot Co.* MECHANICAL & PLUMBING CONTRACTOR: *Comfortaire Co., Inc.* CONSULTING ENGINEERS: *Leo S. Weil; Walter B. Moses.*

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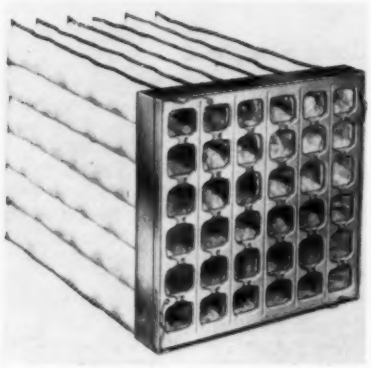
NEW EQUIPMENT



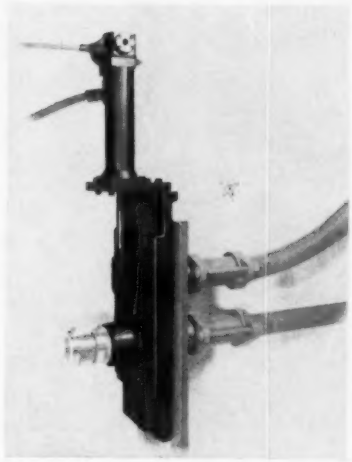
Dry-Type Air Filter

A new dry-type air filter, the AAF Dri-Pak has been introduced by American Air Filter Co., answering the demand for a unit filter of high efficiency, low resistance, compactness, and unusual dust-holding capacity. The Dri-Pak provides air-cleaning efficiencies as high as 97 per cent, based on the National Bureau of Standards dust spot method on atmospheric dust and is adapted for use in industrial and commercial ventilating systems, or in central air-conditioning systems.

The new filter is disposable, extremely light in weight, and requires little storage space. Each 24-in. × 24-in. × 36-in. cartridge in the folded state is only 4 in. deep and weighs just 4 lb. Compact cartoning of the Dri-Pak in a folded state also eliminates the need for large access doors and permits easy corner turns. After the unit has reached final resistance the cartridge, including the header, is thrown away. **—K–1**

Sintered Nylon

Nylasint M4 contains a built-in solid lubricant (molybdenum disulphide) that reduces friction between parts and resists wear throughout life of ball joint. Dimensional stability, close tolerances compare favorably with tolerances for machined metals. Hardened steel failed after 85,000 cycles; sintered nylon continued to function after 1.5 million cycles. Accurate Products, Inc. **—K–2**



Air-Conveying Diverter

Diverting of an air-conveying stream of powdered or granular materials is reported more efficient at less cost using a new line diverter introduced by Flo-Tronics, Inc.

Called the Flo-Seal line diverter, the unit allows fast efficient selection of two conveying lines with no interference or restriction within the conveying line. The unit is available as standard construction in cast iron—Ni-Resist—and stainless-steel construction where in contact with the conveyed product.

The Flo-seal line diverter is self-cleaning and is designed to meet the strict sanitary codes of the food industry. It requires no lubricants and is easily disassembled for inspection or servicing. The diverting speed may be adjusted to individual needs with two-speed control screws located on the air cylinder. **—K–3**

Torque Converters

A new line of torque converters was recently announced by Rockford Clutch Div., Borg-Warner Corp. The new torque converters have been specially designed to provide an infinite number of torque-speed ratios for off-highway vehicles, wheel and track-laying tractors, loader graders, rollers, stationary power units, and industrial drives.

Handling loads from 100 to 700 hp, Rockford's new torque converters have torque multiplication ratios from 2.3:1 to 3.5:1. Sizes range up to $18^{3}/_{8}$-in. dia. The converters are single stage, 3-element type with or without automatic over-running reaction members for fluid coupling operation. The converters match Rockford's power shift hydraulic clutch line. **—K–4**

Solid-State Power Supply

Philbrick Researches, Inc., is producing a new all solid-state dual power supply for energizing transistorized electronic equipment. Designed to take full advantage of semiconductor components, the new Model 6033 power supply operates from 115 volts and provides two fixed voltage outputs: ±15 volts dc, each at 200 ma.

A unique feature is the short-circuit overload protection. The supply is not damaged even by a prolonged short circuit, because short-circuit current is always less than full load.

Regulation against line and load of the new Philbrick power supply is well under 0.01 per cent. Ripple is under $^{1}/_{2}$ millivolt (0.003 per cent). Stability of output voltage with temperature and time depends essentially on the silicon diode reference performance. Therefore, this power supply usually constitutes the basic voltage reference of the control or instrument system it supplies. It can power up to 20 Philbrick Model P2 amplifiers.

This power supply is available from stock in small quantities in three configurations; As a laboratory bench model (with control panel on front); as a modular plug-in (without front panel controls) designed from OEM equipment, instrument systems, computers, and so on, and in a slender configuration designed for plug-in installation. **—K–5**

Worm-Gear Reducers

Ohio Gear Co. has availabe a new "Hi-Line" series of fin and fan-cooled single-reduction worm-gear reducers. Available in more than 100 types and sizes, they provide up to 80 per cent greater load capacity in 25 per cent less space.

Three basic styles are available: Worm above; worm below; and vertical right-angle drive, with center distances from 1.33 to 5.25 in. Ratios ranges from 5:1 through 60:1. **—K–6**

-Installs
BARCO
Self-Aligning
SWIVEL
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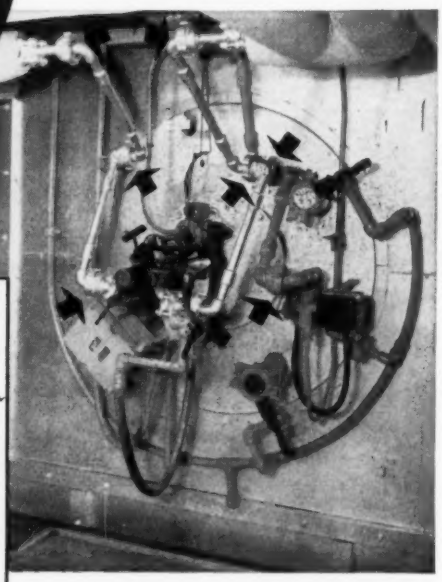
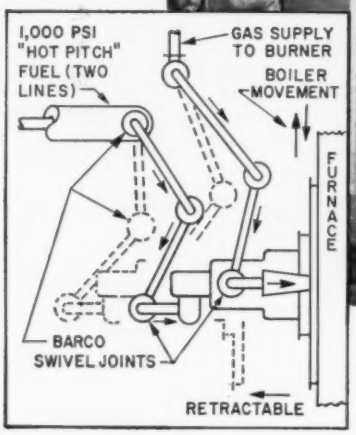
SAFETY for Burners

handling 450° Fuel at 1,000 psi





The above photograph shows three flexible "dog leg" piping connections for fuel fired in a large eastern utility steam generating station. The arrows point to Barco "Self-Aligning" Swivel Joints. The schematic diagram at left shows how the burner installation is readily retractable and also is flexible to allow for boiler movement.

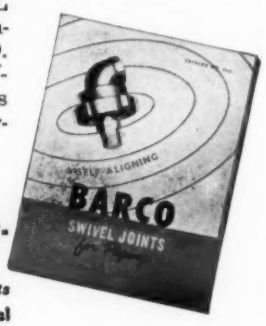
Power Plant Uses Steel Pipe for "Flexible Connections"

THE idea of using steel pipe, instead of hose, appeals to many engineers—especially where fuel is being handled at high temperature and pressure.

In the boiler plant shown above, heavy pitch, obtained from a nearby oil refinery, is pre-heated to 450°—500°F and pumped at 1,000 psi to the burners of the steam generators. On each burner, two 1" lines feed hot pitch; a third 1½" line (painted gray) handles natural gas for auxiliary firing.

Each line is fitted with three Barco Type S All-Steel Swivel Joints with welded connections. Periodically, all lines are purged with 150 psi steam.

With a total of 642 Barco joints installed, only one joint has required any maintenance in two years of service. One of the big advantages of these joints is that they have NO BALL BEARINGS. They don't bake dry at high temperatures. NO LUBRICATION REQUIRED. Another big advantage is that they are *self-aligning;* this eliminates binding and simplifies and speeds up pipe fitting. For detailed information, ASK FOR CATALOG 265D.



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FOUNDED 1903

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The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
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Ozalid Whiteprinter

The Printmaster 900, a deluxe whiteprint machine designed for maximum convenience and flexibility, featuring a new sleeveless developing system, has been introduced by the Ozalid Div. of General Aniline & Film Corp. The Printmaster 900 reproduces engineering and architectural drawings, visual aids materials, and a wide variety of business forms. The 900 accommodates materials of any length and up to 42-in. width; printing and developing speeds are synchronized up to 75 fpm.

The new sleeveless dry diazo developing system assures scratch-proof protection of sensitized films, and eliminates the need for slip sheets.

Compact minimum dimensions 72¼ in. wide by 70½ in. high by 29 in. deep are increased to 84¼ in. in width with the feedboard, and to 76½ in. in depth with the feedboard and rear stacking tray. The Printmaster 900 is wired for 220 volts ac, 60 cycles, single phase. **—K-7**

Cyclone Dust Collector

A wider range of more efficient operation is attained with a new series of centrifugal dust collectors developed by Torit Mfg. Co. to provide up to 2500 cfm of air with a 5-hp motor.

With greater capacities under comparatively low horsepower, these Model 20 cyclone separators expand the Torit line of industrial dust collectors and extend the number of applications possible with a single series of collectors.

Capacity of the Series No. 20-3, 3 hp, ranges from 1250 to 2000 cfm, and the No. 20-5, 5 hp, to 2500 cfm. Variations of these separators include models with after filters for indoor exhausting and enlarged dust storage and hopper capacities. A total of 12 models is available in the new No. 20 series. **—K-8**

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Speed Reducers

Cleveland Worm & Gear Division, Eato Mfg. Co., announces the addition of vertical units to its new line of fan-cooled, worm-gear speed reducers. Nine sizes, ranging from 3 to 12-in. center distances, are available. Ratios extend from $4^1/_7$:1 to 95:1; ratings are fractional of 175 hp.

The new units incorporate fan cooling, specially hardened worms and centrifugally cast gears, such as were originally designed in the first reducers of the fan-cooled line. They have a much higher average rating than comparable reducers not having an auxiliary means of cooling. All of the new vertical units have one-piece finned housings for maximum strength and heat dissipation.

—K-9

Portable Liquid Loader

A new, portable liquid loader is now available from OPW-Jordan. Originally designed for and used by the U. S. Army, the 2-in. bronze and aluminum K-59 liquid loader finds wide application in industry, particularly in new construction. It is used wherever large quantities of liquid must be loaded and unloaded as efficiently and economically as possible. The K-59 liquid loader is small, lightweight (only 198 lb), compact and complete in itself since it provides its own support and is adaptable to any terrain. Drawings, dimensions, complete information, and prices availabe in two-page Bulletin PNB 3-61.

—K-10

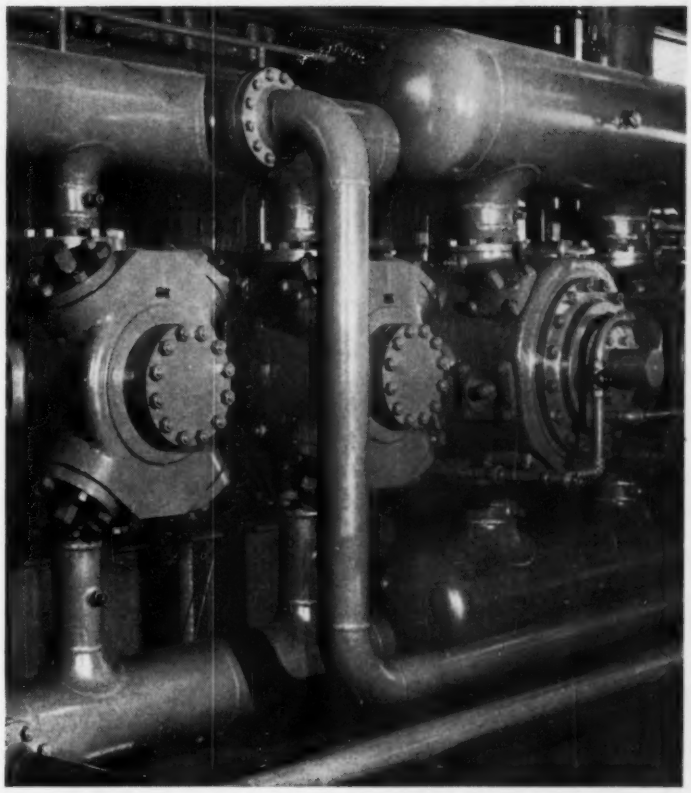
Green Aluminum Coating

Rust-Oleum 1030 green aluminum, recently announced by Rust-Oleum Corp., is specially formulated to produce a tough, durable, attractive finish for widespread use by industry and municipalities. It incorporates the same high-quality ingredients as other Rust-Oleum exclusive formulations to resist moisture, sun, fumes and weathering.

Green aluminum is ideally used as a top coat on exterior and interior surfaces; with its pleasing color it is of particular interest for use on tanks, structural steel, metal sash, piping, wire fences, metal roofs, and buildings.

—K-11

PACKAGED COMPRESSOR PIPING...



another example of

BONNEY SWEEPOLETS®

for sophisticated piping systems

Designed to eliminate all notch effects, the Bonney Sweepolet provides optimum stress distribution for critical piping systems such as the compressor bottles shown above on Worthington SLHC-10 gas engine angle compressors rated at 950 BHP each. These units were fabricated by Worthington-Lockett using Bonney Sweepolets for branch construction. Specify and use Bonney Sweepolets in your critical piping systems.

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Trim Potentiometer

A miniature trim potentiometer, developed by Liquidometer Corp. for trimming adjustments on many of its hermetically sealed instruments, is now available to other manufacturers. Sealed metal-to-metal construction of the Type B329 potentiometer provides a true hermetic gas barrier while permitting external trim adjustments to be made.

Service-proved on thousands of Liquidometer gaging systems for aircraft fuel and liquid oxygen, the lightweight (1/2 oz) B329 is small in size, and of rugged construction and high resolution. It is easily installed, with a grooved surface and a snap ring to simplify positioning. Encased in a nickel-plated brass housing, it has a hinged protective cover which may be safety wired shut after trimming adjustments have been made.

The B329 potentiometer has a resistance range up to 8400 ohms, a power rating of 1/3 watt at 85-C continuous operation, and an operating ambient temperature range from −50 to +100 C. **—K-12**

Spray Nozzle

Spraying Systems Co. has introduced its 8651 1/4 JAUH automatic hydraulic spray nozzle with the unusual feature of a clean-out needle that automatically clears the orifice with each on-and-off cycle of the nozzle. This is done by means of a clean-out needle extension of the orifice shut-off valve. Each time the valve closes the clean-out needle moves through the orifice opening to clear out any solid residue that might otherwise adhere. Compressed air is used to actuate the valve. The precision air-cylinder actuating mechanism may be operated at any speed up to 180 cpm. These new spray nozzles are supplied in a choice of interchangeable orifice tips. **—K-13**

Fractional HP Speed Reducer

Abart Gear & Machine Co. Type 2-5/8A speed reducer provides speed ratios from 5 1/2 to 1 up to 100 to 1, handling inputs of 1/4 to 2 hp at 1800 rpm, and 1/6 to 1 1/2 hp at 1200 rpm. Right-angle drive, horizontal worm gear speed reduction unit is built for continuous duty in stokers, conveyors, agitators, spraying equipment and hundreds of other applications. Fully enclosed, it may be mounted in any position.

This speed reducer is made with case-hardened and ground alloy-steel worm integral with its shaft. Nickel-bronze worm wheel has alloy-steel, heat-treated shaft. Ball bearings are used throughout. Oil-tight semi-steel housing contains all bearing supports to guarantee permanent alignment and eliminate split bearings. Base is also semi-steel and includes a large oil reservoir. These reversible speed reduction units may be furnished with input or output shafts projecting from either side of the housing, or from both sides. **—K-14**

Spectrophotometer Glass

A new type glass developed by Corning Glass Works provides a method for quick and precise calibration of recording spectrophotometers for wavelength accuracy. With filters made of this glass, instrument accuracy can be determined in a few minutes by routine scanning.

To produce these filters, Corning research scientists successfully combined holmium, a rare earth element, and a special glass that transmits radiant energy in the ultraviolet region of the spectrum between 200 and 300 millimicrons. Most glasses do not transmit in this region.

The new glass, identified as Corning Code No. 3130, is available in the form of flat plates from Corning's Optical Sales Dept. It is stable, nonvolatile, noncorrosive, and nontoxic. **—K-15**

Compact Multipoint Recorder

The new Westronics Inc. Model M11A compact multipoint strip-chart recorder is only 8 1/2 in. high and will mount easily in a 19-in.-wide relay rack panel. The recorder will scan and measure 2 to 12 input sources at the rate of 5 sec per point. Faster or slower print rates may be specified. Calibrated chart width is 11 in.

Plug-in range change modules permit almost instantaneous range changes to other temperature spans or from temperature to millivolt spans and vice-versa, because no thermocouple wire is used in the recorder. The cold junctions and compensating resistor are enclosed in a thermally insulated package in the rear of the recorder.

The Model M11A Multipoint recorder has six separate ink pads providing six color printing, if desired. "Dialomatic" four-speed chart transmission, adjustable alarm switches, retransmitting slidewire, "print-no-print" point selection, and a detachable ball-point pen for continuous single-point records are some of the many optional features available. Descriptive catalog available. **—K-16**

Boosting Pump Line Pressure

An efficient, compact pump designed to boost system pressure right in the distributing line has been announced by Peerless Pump, Hydrodynamics Div., Food Machinery and Chemical Corp.

Trade-named, "Hydro-Boost," the new pump is a submersible, turbine-type unit. It is designed for continuous duty and provides a ready solution to adding a booster station on lines requiring additional pressure to serve newly developed areas.

The pump is available with capacities up to 8000 gpm, heads to 1000 ft, and motors up to 350 hp. It can be placed in lines ranging up to 16 in. dia. **—K-17**

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NORWALK COMPRESSORS ARE INSTALLED IN MANY MILITARY BASES, NAVAL SHIPYARDS AND SHORE ESTABLISHMENTS ON THE CONTINENT AND OVERSEAS.

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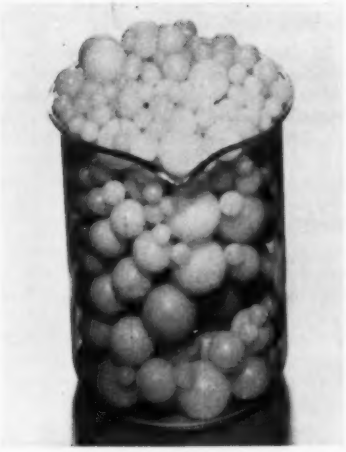


Ball Bearings

Industrial Tectonics, Inc. offers the widest array of new and improved products in its 15-year history. Close-tolerance balls of new ceramic, metallic, and plastic materials are available, including special bearings for corrosive and extreme temperature applications; check-valve quality balls of delrin and lexan as well as the more widely used nylon and Teflon; tungsten-carbide ball plug gages which speed-up hole checking; and bearings designed to operate within liquid hydrogen at −425 F. **—K–18**

Retaining Rings

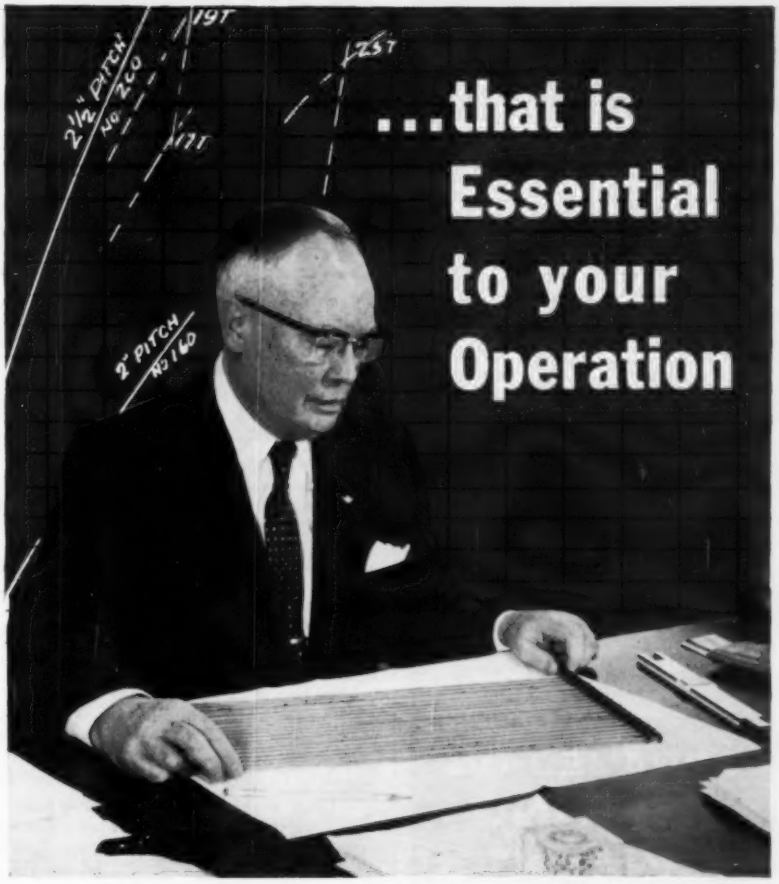
Following up the initial prestacking of internal retaining rings, Industrial Retaining Ring Co., has succeeded in prestacking external axial assembly retaining rings so that they are now commercially available.

Pre-stacking these Industrial Series 3100 retaining rings brings to industry many ad vantages that have been, until now, economically unattainable. Because, for example, prestacked Series 3100 rings come with the lugs perfectly aligned, they can be easily used in automatic or semi-automatic assembly systems. Also, there need be no loss of time through sorting or untangling. . .and inventory controls are greatly simplified since 250 rings are in each stack.

Industrial Series 3100 external axial assembly retaining rings are available for immediate delivery either prestacked or bulk packed. Prestacked sizes range from shaft diameter 0.250 to 1.375; bulk from 0.125 to 3.438 in. Ask for Industrial Retaining Ring Catalog No. 31. **—K–19**

FOR CONSULTING ENGINEERS TURN TO PAGE 166

Here's Engineering Service...



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Whether it's technical advice or field assistance, it has always been and will continue to be part of Acme's Basic Policy to make "all the knowledge and assistance of their Engineering Department" available to help manufacturers solve their problems.

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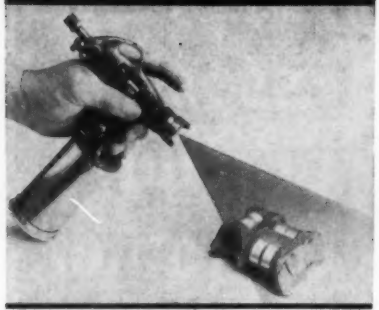

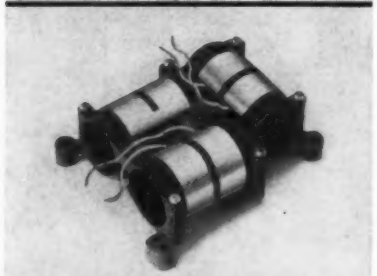

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Electrofilm's sprayed on — film type heating elements are especially designed for hard to heat contour surfaces. The element can be applied directly to the part . . . or to detachable components.

- **LIGHT WEIGHT** .07 lbs./sq. ft.
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Magnetic Brake

High torque-to-size ratio with precise control features electromagnetic brake with range of diameters from 2.25 to 11.5 in. and torque ratings from 35 to 32,500 in-lb. Fawick Corp. Airflex Div. **—K-20**

Universal Sealer

Bag-O-Matic Packaging Equipment Co., announces a low-priced universal sealer. It seals polycel, all pliofilms, and handles polycoated kraft for Government work, as well as all gages of polyethelene.

The sealer, weighing only 20 lb is made of solid cast aluminum and is cam driven. Features include a safety slip clutch and newly designed heat-input regulator which maintains heat to ±2 F. The sealing bar is solid brass and adjustable for leveling purposes. Teflon clip holders are supplied for rapid changeover to seal polyethylene bags. **—K-21**

Heavy-Duty Press

The largest Havir-Press-Rite ever built, a 125-ton OBI Model, has been announced by Havir Mfg. Co. The new press features ruggedness of design, new safety extras, versatility of application and increased die life.

"Large working area for handling heavy-duty, bulky jobs was a key requirement for the Havir engineers when they designed this press," Havir reported. "The die area measures 30 by 44 in., with proportionately large working area between the tie rods. Shut height is standard at 17 in. with a 4-in. stroke."

This press is available in air-clutch flywheel or air-clutch backgeared models. It has 28-in. opening in the back of the frame with an extra deep throat of 16 in. Traditional heavy-duty Havir construction went into the design of this new Press-Rite, the manufacturer stated. **—K-22**

Temperature Regulator

A new, self-operated, stainless-steel temperature regulator is now available from OPW-Jordan. Body and all wetted parts are stainless steel to handle tough chemical applications and corrosive or erosive conditions; also suitable for steam, water, air, oil, and gas. Available from stock in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, 1, and $1\frac{1}{4}$ in. capacities for immediate delivery with 316 stainless-steel bodies. Stainless-steel trim is standard with linear characteristic sliding-gate seats. Seats are self-cleaning and self-lapping in operation to provide tight shut off and help minimize maintenance. The valve also has a field removable thermal system in case a range change is desired in the field. Full engineering information, cut-aways, drawings, features, names of parts, materials of construction, ratings, flow curve, sizing charts, dimensional drawings, and prices are shown in the two-page Bulletin JNP-6 and one-page SRBc 27-61. **—K-23**

Portable-Type Air Filters

The development of two highly efficient, portable air filters with direct application to a wide variety of vacuum-type pneumatic unloading systems was announced recently by officials of Fuller Co. One, the intake filter, is to filter air taken into the conveying system itself and the other, the hatch filter, is to filter air drawn into the bulk carrier during unloading.

Originally designed for use in conjunction with the unloading of cars involved with the bulk transport of polyethylene and polystyrene pellets, applications are predicted for these new units for filtering inlet or make-up air on any vacuum unloading system where sanitation or prevention of product contamination is important.

The conveying air intake filter is designed to attach directly to the car unloading nozzle by means of a slip coupling, while the car vent filter is placed directly on the open car hatch. Both units are of stainless steel and aluminum construction. Filters feature a replaceable cartridge of high efficiency and permeability that can be washed and reused. **—K-24**

Soft-Seat Valve Plugs

Soft-seat plugs which provide tight shut-off without sacrificing flow characteristics or capacity have been developed by Mason-Neilan, Div. of Worthington Corp., for Masoneilan 2000 series control valves.

Because of the growing preference for single-seat valves in many process and power applications, Mason-Neilan has broadened the line to include soft-seat plugs for static pressures and pressure drops up to 500 psi, with no leakage whatever into the line or through the threaded parts of the valve.

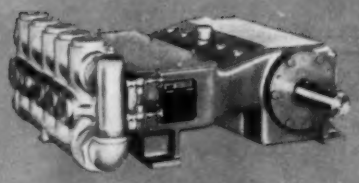
Design of the plugs is such that there is metal-to-metal backup for the soft seat inserts which, in closed position, are fully retained and will withstand differential pressures in excess of 1000 psi. **—K-25**

Rotating Union

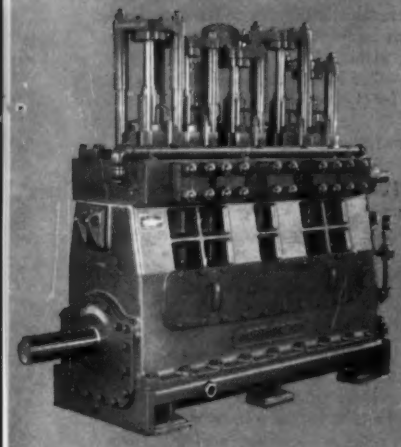
To solve the need for a slow speed, economically priced double passage rotating union, the Deublin Co. has designed and developed a new model for this type of service.

This Model 1595 is for installations which require a means to introduce two different mediums or the same medium through two different passages. It is rated at 150 psi air pressure, 1000 psi hydraulic oil pressure with rotational shaft speeds up to 200 rpm.

This slow speed union is the answer for operations requiring double passage conveyance of air, hydraulic oil or other materials on equipment such as heavy duty earth moving machinery, material handling equipment or for any device which utilizes air or hydraulic cylinders or clutches that either rotate or oscillate. **—K-26**



HORIZONTAL PLUNGER PUMP
25 sizes—15 to 160 HP



VERTICAL PLUNGER PUMP
135 sizes—20 to 900 HP

Choose a Worthington plunger pump . . .

ODDS FAVOR YOU—160:1

Yes, you can choose from 160 standard sizes in the basic Worthington plunger pump line—25 horizontals, 135 verticals. You get 160 chances to be right from our basic pump models. But that isn't all.

In both lines, speeds can be varied, still other plunger and cylinder sizes are available. So each type can be tailored to deliver a very exact performance.

Remember, you choose from two basic types—horizontal or vertical. Each has its basic benefit. The horizontal power pumps have extremely low first cost; the vertical power pumps are designed for extremely rugged, long-life service.

Both vertical and horizontal Worthington power pumps are engineered to give the most reliable possible performance for their type. Stainless steel valves and Colmonoy plungers are typical long-life features.

You'll find both Worthington power pump types are designed for easy maintenance. There is fast access to valves through individual valve covers—piping remains undisturbed. Each cylinder size will accept a choice of plunger diameters to suit service conditions, and other parts are interchangeable between similar models.

Yes, because of the breadth and flexibility of the line, Worthington power pumps can be matched quickly to any power pump installation.

For information, write Worthington Corporation, Dept. 32-12, Harrison, New Jersey. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

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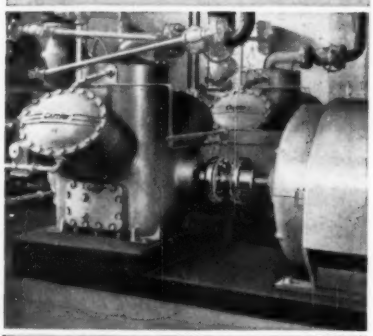

THOMAS FLEXIBLE COUPLINGS

Think of the losses incurred by maintenance costs, lubrication, down time and damage to connected machines by inadequate couplings.

High degree of accuracy, reliability and performance make Thomas "All-Metal" Flexible Couplings the best in the world . . . . . the only Flexible Couplings designed on the Correct Principle to give lifetime service without maintenance.

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WARREN, PENNSYLVANIA, U.S.A.

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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Indicating Pneumatic Controller

An improved version of Robertshaw-Fulton indicating pneumatic controller, announced some months ago, is now available from the company's Fulton Sylphon Div. In its latest form, the controller incorporates a new nonbleed relay which offers savings in air consumption. Ranges of the pressure model have been extended to 500 psi. Temperature ranges are now available to 1000F.

Company officials say the new version also offers reduced friction and lower maintenance through the use of simplified design, incorporating fewer pivots in the mechanism. The Robertshaw No. 1150 series indicating controller, say these officials, uses less than half the number of pivots found in competitive makes.

Further details are available in Bulletin No. SF-757. **—K-27**

Pressure Gauges

A new series of $2\frac{1}{2}$-in. pressure gauges, to be known as the Marsh "Service Gauge" series, has been announced by Marsh Instrument Co., Div. of Colorado Oil and Gas Corp.

According to the manufacturer, the new series has been developed to provide a highly accurate and sturdy gauge of a type that fulfills a wide range of in-plant and original equipment requirements.

Two types of bourdon tubes and movements are available: Type 11 has a silver-brazed copper alloy bourdon tube and bronze-bushed movement for pressure media not corrosive to brass. Type 11S has a 316 stainless-steel bourdon tube, with 303 stainless-steel tip and socket, and a movement of stainless steel and monel—therefore corrosion resistance.

All gauges are $2\frac{1}{2}$-in. dial size with $\frac{1}{4}$-in. NPT male bottom connection. Ranges are 15, 30, 60, 100, 160, 200, 300, 600, 1000 psi, and 30-in. vacuum. **—K-28**

Thermostat

A $\frac{1}{4}$-in.-diam Model BW-SS insulated thermostat is available with Chatham's patented wiping action and contacts that open and close with temperature fluctuations. This, and other Chatham models can be factory calibrated or adjusted externally to obtain the desired actuating temperature by means of an easily accessible adjustment screw which may be hermetically sealed at the factory or by the customer. Temperature setting is not affected by ambient temperatures.

The model incorporates a bimetal-actuated contact attached to a spring which shunts the bimetal. This model is particularly recommended for applications requiring an insulated thermostat with the maximum contact rating. Maximum differential 1 deg C. For additional information and specifications write Chatham Controls Corp. **—K-29**

Cryogenic Pipe Joints

Development of a distinctive new type of flexible joint providing gimbal and swivel movement for cryogenic piping is announced by Barco Mfg. Co. Built specifically to meet newest missile and space-program requirements in handling liquid oxygen, the new joints also have equally desirable features for handling virtually all other fluid chemical or petrochemical oxidizers and rocket fuels, as well as liquefied gases and chemicals in industry, within the temperature range from −325 to −275 F. Principal service applications are for (1) pipe expansion or contraction joints, (2) flexible metal loading arms, and (3) swivel-joint use.

These new joints are designated as the Barco "Featherweight" series in 2, 3, 4, 6, 8, 10 and 12-in. size, with welding or flanged ends, for operating pressures to 200 psi. **—K-30**

Spray Guns

Spraying Systems Co. has introduced a new line of No. 22 series "GunJet" spray guns to provide greater reach with drip-free shut-off. These guns for airless paint spraying are built in a choice of four models with extension lengths of 8, 18, 24, and 36 in. In each model the valve stem extends the entire length of the extension tube. The shut-off needle is positioned immediately behind the nozzle orifice for positive, drip-free shut-off.

Over-all design includes many important features: Tungsten-carbide valve seat and needle assure long-life operation. Stainless-steel body, extension tube and cap and Teflon packings provide maximum corrosion resistance to chemicals. Easily controlled trigger mechanism is external to the paint-carrying part of the gun for dependable performance. Trigger lock permits effortless continuous operation. Light in weight and balanced. For use in airless paint spraying and coating at pressures up to 2000 psi. **—K-31**

Vibratory Feeder

Of special interest to the food, chemical, mining, and heavy industry fields is the infinitely variable control of materials flow that is possible with the Para-Mount vibratory feeders produced by the General Kinematics Corp.

Adjustable or fixed rate models are capable of handling up to 750 tons per hr. These feeders may be used singly or in combination for accurate control of process operations. A standard, fully enclosed 900-rpm motor with small counterweights provides an exciting force that is amplified through the resonance action of heavy-duty shear springs to develop the dynamic forces required to vibrate the trough. Adjustable-rate models utilize air springs to vary the stroke and feed rate. A full-range air control is another exclusive feature of the Para-Mount line. Bulletin 611 is available. **—K-32**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Butterfly Valves

A new line of butterfly valves has been announced by the Lunkenheimer Co.

The new valves are rated at 150 lb water pressure and cover a pipe-size range from 2 to 18 in.

Lunkenheimer's butterfly valves have nickel-plated cast-iron or cast-steel bodies with stainless-steel trim. For special applications, a variety of alternates is available, including rubber or ceramic lining, monel trim, and aluminum-bronze disks.

In diameters up to 6 in., the valve may be obtained as an integral unit. In the full range of sizes, up to 18 in., the valve is a separate element with interchangeable bolt-on flanges for screw, weld, flange, or groove installations. **—K-33**

Booted Universal Joints

A new line of booted universal joints has been especially developed by Lovejoy Flexible Coupling Co., for severe service applications. These include: (1) heavy loads, high speeds and/or high heat; (2) contact with dust, dirt and other contamination; and (3) any situation where lubrication with oil is difficult or impossible.

The joints are fitted with oil-resistant neoprene covers which allow them to be prepacked with grease. The line incorporates both standard and heavy duty types. Standard duty booted joints are available from $\frac{3}{8}$ to $2\frac{1}{2}$ in. od, with static torque range from 220 to 30,000 in-lb, horsepowers from 0.35 to 120 and speeds to 1500 rpm. Heavy duty booted joints come in the same od static torque range from 540 to 48,000 in-lb, horsepowers from 0.86 to 230 and speeds to 1750 rpm. **—K-34**

Pump Operation Visualized

Dean Brothers Pumps Inc., has adopted a unique closed-circuit television method for tracing performance of its products. Closed circuit TV allows the viewer to operate the new pump and at the same time trace its performance on the TV screen. One can duplicate his own plant's operating conditions by means of valves, one on the suction, the other on discharge.

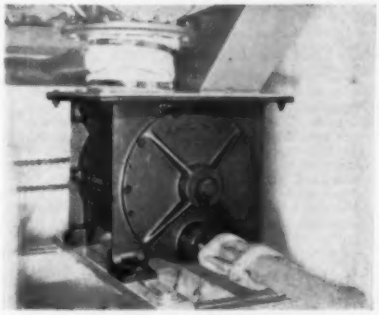
This method was used at the National Plant Maintenance and Engineering Show in Chicago, earlier this year to demonstrate Dean's new pH pump in operation. This pump embodies design features which provide low first-cost and lowest long-run cost. Center-line suction and discharge make installation simple and inexpensive. PH pump can be dismantled easily for servicing without disturbing either suction or discharge piping. Maximum interchangeability of parts makes it possible to change the pump capacity by merely changing the casing and impeller, reducing costs of maintenance and spare parts inventory. Dean Brothers pH pumps are available in 14 different sizes and 17 different alloys. **—K-35**

Increase efficiency, cut cost with

FLO-TRONICS AIR CONVEYING

Systems and Equipment

Flo-Tronics complete air conveying systems and system components are designed to meet your specific requirements. Systems include complete automatic controls. Equipment is available as standard, in cast iron, chrome-plated, NI-Resist and stainless steel construction.



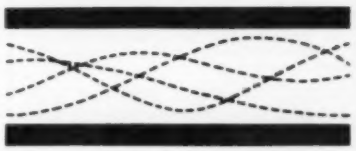
New "SWEEP-FLO" Conveying Valve

Workhorse of the Flo-Tronic Air Conveying Systems is the "Sweep-Flo" Conveying Valve. It introduces granular material into an air stream at a predetermined constant rate. High capacity operation is 15% more efficient than competitive models due to larger size inlets.

Has exclusive axially shaped rotor pocket that moves product with clean sweep and deflected rotor blades that prevent "bubbling." Sealed bearings can't contaminate product through contact. Available in 1½ inch through 10 inch conveying line sizes.

"Sweep-Flo" Conveying Valve is versatile, easy to install, needs only minimum maintenance.

Flo-Tronics engineers are anxious to assist you with your air conveying problems. Write today for "Sweep-Flo" Conveying Valve product sheet and systems brochure. No obligation of course.



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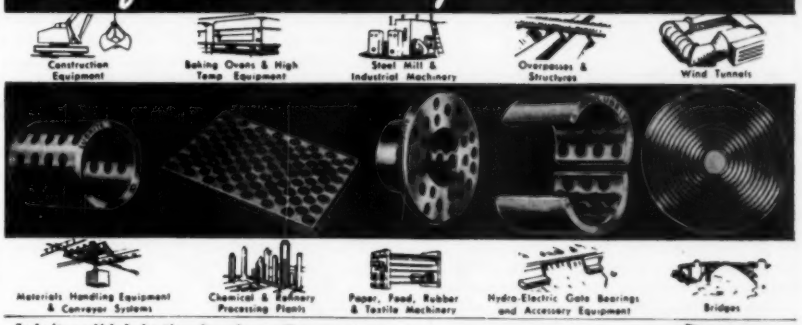
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Consult our Engineering Department on your application. No obligation.

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PHYSICAL PROPERTIES RESEARCH

To conduct studies of physical behavior of solid propellant rocket component materials, including propellants, adhesives, and laminates, for performance prediction and motor design improvement. Devise laboratory tests to duplicate long-term storage effects, shock and acceleration forces during rocket firings, etc., and correlate the results with full-scale rocket motor static firing performance. M.S. in engineering or science with experience in physical properties measurement, polymer and viscoelastic physical properties, stress analysis, and statistical and mathematical ability.

PRODUCTION ENGINEER

For methods improvement to increase efficiency and reduce costs in production department involving welding, sheet metal work, machine shop, electrical circuitry, painting and assembly operations in the production of dehumidification equipment. B.S. in mechanical or industrial engineering with an energetic approach.

ROCKET PROJECT ENGINEERS

To work on prototype development of solid propellant rocket propulsion systems. Involves coordination of programs with mechanical design, ballistic, instrumentation, and test engineers. Requires personable men with interests and demonstrated abilities to carry systems from inception through test and qualification. B.S. or M.S. in mechanical or chemical engineering with the ability to work effectively with others.

ROCKET ASSEMBLY SUPERVISOR

To supervise solid propellant rocket motor assembly, including personnel training, production scheduling, procurement, cost analysis and reduction, methods study, and anticipation of future business trends requiring expanded facilities. He must maintain a proper working relationship with suppliers, as well as intra- and inter-division personnel. B.S., M.S., in engineering with five years' mechanical and production experience.

R & D APPLIED MECHANICS—STAFF ENGINEER

To work with Mechanical Engineering Division Director as applied mechanics specialist in fields of stress, heat transfer thermodynamics, on both practical problems and the organization of original R & D proposals. M.S. in mechanical engineering with good academic record.

DESIGN ENGINEERS

To work in Rocket Design Section on design, and development of high-performance rocket motor light-weight hardware. Design scope involves inert component design, knowledge of gas dynamics for solid propellant rocket nozzle design, pressure vessel construction, and metallic and non-metallic materials applications. B.S., M.S. in mechanical or aeronautical engineering with experience.

Atlantic Research Corporation is an expanding contract research and development company, located in the Washington, D. C. Metropolitan area. Its technical interests range from solid propellant rocket development and manufacture, through electronics and electromechanical instrumentation, to research and development of new and improved plastic materials.

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Technical Personnel Recruitment ME

Atlantic Research Corporation
Alexandria, Virginia

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Squirt Welder

The Lincoln Electric Co. is manufacturing a new semiautomatic production welder for use on both machinery and structural fabricating. The innershield squirt welder continuously feeds a tubular, self-shielding electrode through a welding gun that is manually supported and guided along the joint being welded.

Designed to provide the high deposition rates of an automatic process while maintaining the flexibility and adaptability of manual welding, the compact 24-oz welding gun closely duplicates the feel of a standard 500-amp electrode holder. A d-c motor-generator supplies power for the welding range of 350 to 600 amp. Amperage control is achieved by varying wire feed speed. Current and arc voltage controls are conveniently located on the tilted control panel of the welder. This panel also contains an electrode inch button, polarity switch, and volt and ammeters. **—K–36**

Heavy-Duty Valves

Two new block steel valves for continuous, heavy-duty flow regulation applications have been added to the line of quality industrial instruments and regulators produced by McAlear Manufacturing Co.

Specifically designed for rugged applications, these valves are used in continuous boiler (surface) blowdown systems, hydraulic service, instruments, throttling service, water-column blowdown, soot blowers, boiler-sampling service, and flow control of volatile liquids (anhydrous ammonia, chlorine, etc).

Featuring a heavy design and extra thickness at all wear points, these valves are available in carbon steel or chrome-moly steel. They provide accurate flow regulation within 1 per cent of desired flow. They also resist excessive cutting arising from continuous throttling of a liquid. Pressure-temperature limitations of the new McAlear valves are 1500 psi at 800 F. **—K–37**

Hydraulic Pumping Units

Pressures ranging up to 2500 psi and flow rates from 0.6 to 4.2 gpm are offered in the new Racine Junior series of hydraulic pumping units now being introduced by Racine Hydraulics & Machinery, Inc.

These self-contained and low-cost power units are designed for a wide range of industrial-machinery applications. Among them are lift trucks, small clamping mechanisms, gate-valve operations such as are used in refineries, dams, chemical plants, etc., container-industry equipment or food processing equipment.

As a special assembly feature, the base of the Racine Junior forms the oil reservoir, motor, pump, filler, and breather assembly and pressure, and return connection are mounted as an assembly on an aluminum die-casting base plate that forms the cover for the reservoir. **—K–38**

Wash-Off Drafting

Dupro, a new polyester wash-off film made by Keuffel & Esser Co., produces erasable ink-black lines from pencil originals, and permits ink or pencil-drawn additions.

Ink-like "second originals" are made on Dupro from pencil drawings, with lines that won't smudge yet are easily removed with a soft, moist eraser. Additions or corrections are then drawn on the Dupro surface and the revised reproduction may be used to produce sharp reprints at high machine speeds.

Using the Dupro reproduction as a "second original" saves time since it eliminates the need for redrawing those elements of the original which remain unchanged. Also, the original may be retained for future reference and use.

The new film has high transparency for reproduction, long shelf-life expectancy without loss of wash-off characteristics, exceptional durability, water-resistance and pencil, ink, and typewriter "take," according to the company.

Dupro's ink acceptance is regarded as a major improvement over many drafting films which tend to make inked lines "feather." **—K–39**

Electro-Magnetic Clutch

Benchmaster Mfg. Co., has announced its positive electro-magnetic clutch, adaptable to all new as well as existing Benchmaster punch presses (except 1 ton and 2 ton models). Mechanical linkage is eliminated and since no slidings keys, normally used in mechanical clutches, are required, breakage hazards from this source no longer exist. Actuation lag is greatly reduced; pick-up occurs instantaneously over any portion of the flywheel rotation, making possible certain flying cut-off applications. Multiple press installations can also be automated with single program.

When clutch is released, press operation is instantly stopped by an electro-magnetic brake. Operation is quiet, less fatiguing than manual presses, and offers unusual operator safety through a wide choice of operating methods.

A Teletrol Model TL800 electric press control is used in conjunction with the electro-magnetic clutch which is said to virtually eliminate the possibility of operating the press in any manner other than selected. The Dial-A-Matic feature permits dialing choice of operating method-automatic (continuous run) or any of the single trip positions: foot, left or right hand, two-handed safety, etc. A jog position is also provided. After dialing the chosen method of operation, Dial-A-Matic is placed under lock and key to prevent unauthorized tampering.

The clutch and Teletrol press control operate on 110 volts ac and are suitable for use on presses operating within the approximate range of 40 to 300 strokes per minute. Literature is available. **—K–40**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Frequency Meter

A wide-range pulse-count electronic frequency meter (Type 1142-A), direct-reading over a range of 3 cps to 1.65 Mc, has been developed by the General Radio Co.

By means of a calibrated scale-expansion technique, a direct-reading accuracy of 0.1 per cent is achieved.

In addition to its use in direct frequency measurement, the instrument can be used to make highly precise frequency-drift measurements on oscillators and other generators.

A d-c output for operating a recorder is provided; this is particularly useful in frequency-drift measurements.

The over-all size of the frequency meter is $5^7/_8 \times 12 \times 11^5/_8$ in. —K–41

Seal Ring Assembly

A seal ring assembly that claims to seal off large differential pressures in applications in which ordinary O-ring seals extrude and fail is available from Bowen Itco, Inc.

This assembly has been proved in hundreds of applications, some of which required sealing off differential pressures greater than 50,000 psi. It can be supplied for all ranges of O-rings in diameters ranging from less than $^1/_4$-in. to many feet.

Successful uses of the Bowen seal ring assembly include sealing the head of a 10,000 psi pressure vessel in the laboratory at Southwest Research Institute. The 30-in. dia of the vessel expands $^1/_{16}$ in. from 0 to 10,000 psi. The seal assembly's non-extrusion ring takes up this expansion and prevents extrusion of the O-ring. Use of the seal assembly and a multiple-lead thread makes access to the vessel quick and easy.

Another application of the seal ring assembly is in hydraulic cylinders that lift and level huge offshore drilling platforms. Assemblies for these systems range from 8 in. to 12 ft in dia. —K–42

Cryogenic Pumps

Line-mounted, cryogenic pumps, driven by flooded electric motors, have been introduced by Pesco Products Div., Borg-Warner Corp.

These flooded electric motors are one of the outstanding features of Pesco cryogenic pumping units. With minor modification the pumps also may be used in tank or sump-mounted installations.

Designed to operate at temperatures from −290 to −420 F, Pesco cryogenic motors are extremely small in size in relation to the power output. Typical of this design is the Pesco 50 hp, 3-phase, 400 cycle, a-c cryogenic motor which is 6.50 in. dia, 7 in. long and weighs 30 lb. At the normal operating speed of 24,000 rpm, motor efficiency is 90 per cent. —K–43

MANY FAST'S HAVE BEEN WORKING LONGER THAN YOU

It's a fact. There are plenty of cases where Fast's Couplings have been in service 20 to 40 years. And some of our more enthusiastic engineers say a Fast's should last forever if it's properly applied, installed and lubricated. Whatever opinion you accept, you can bet Fast's Couplings will give you the same smooth-running, low-maintenance, long-lived performance that makes them the choice of more equipment manufacturers than any other gear-type coupling.

For example, Fast's Coupling No. 1347, shipped in July, 1922, is still in service—and the customer is just ordering his first spare coupling 38 years later.

KOPPERS COMPANY, INC., 506 Scott Street, Baltimore 3, Md.

KOPPERS FAST'S COUPLINGS
Engineered Products Sold with Service

Circle No. 81C on Readers' Service Card

Variable-Speed Drive

A variable speed drive, V*S Statatron, has been introduced by the Reliance Electric & Engineering Co. The Statatron is a static powered drive for wide range variable speed from in-plant a-c circuits, available from 1 to 200 hp.

The Statatron uses silicon diodes and saturable reactors to rectify the current from a-c to controllable d-c. They work in combination with the transistorized power exciter to supply variable voltage. —K–44

Aluminum Paint

A new high heat aluminum paint, reputed to withstand temperatures up to 1200 F, has been announced by Speco, Inc.

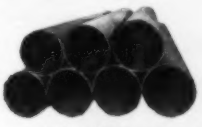
Known as Heat-Rem H-120A, it is a companion product of Heat-Rem H-170. The latter is recommended for temperatures up to 1700 F.

Heat-Rem H-120A is said to be economical for either interior or exterior use. It can be applied by brush, spray or dipping, and will air dry or bake dry. Of extra heavy viscosity, it provides a thick, flexible coating, claimed to be resistant to industrial fumes, most acids, salt spray and weathering. When desirable, for purposes of uniform appearance, it can be applied successfully to wood or masonry adjacent to coated metal.

Available in 1- and 5-gal cans, Heat-Rem H-120A conforms to government and industrial specifications for heat resistant coatings. —K–45

POSEY

LARGE O.D. STEEL PIPE



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Nugent Fig. 1555 Filter Cartridge provides excellent micronic efficiency.

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deliver positive filtration . . . longer

That's the report from the Alco Engineers after examining the performances of three Nugent Filtered Alco 251 Diesels used on pipeline pumping service. That's a fine record, but it becomes even more impressive when you realize that these lube oil filters are averaging approximately two years between recharges.

The filters employed are Nugent's Fig. 1555 Laminated Fiber Disc Type. They filter all the oil in circulation every cycle before it goes to the bearing. Foreign particles as small as 2 or 3 microns are removed . . . oil is kept cleaner . . . oil life is extended.

Longer cartridge life with cleaner engines . . . if that's what you're looking for in a filter, write today for more information on Nugent's complete line of Laminated Disc Type Filters.

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Circle No. 99 on Readers' Service Card

LATEST CATALOGS

Abrasive Products

Abrasive Products for the Construction Trades, a new 42-page booklet by the Carborundum Co., catalogs a complete line of abrasives and related products for the masonry and concrete trade. It is a quick reference reliable handbook based on more than 60 years of abrasive experience.—K-46

Air-Conditioning Maintenance

Associated Laboratories, Inc., has issued Bulletin No. T-51 giving suggestions for maintenance of water-cooled air-conditioning systems with start-up procedures and operational practices.

Associated Laboratories is made up of a group of independent water-treatment companies located across the nation, with the co-operative objective of working to improve products and methods for the prevention of scale and corrosion in water-handling equipment. —K-47

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Gas-Density Detector

Gow-Mac Instrument Co. announces a line of gas-density detectors for simple, quick, accurate, reliable operation in Bulletin Gade 461.

The company states that the Gow-Mac gas-density detector is the only detector in use today that measures a single-additive physical property of the chromatographic gas; i.e., a property that depends upon only the number and kind of atoms in the molecule. If the molecular weight of the components are known, chromatographic peak areas can be converted directly into weight per cent. If the molecular weights are not known they can be determined by the gas-density detector. —K-48

Diaphragms

Elastomer-fabric diaphragms are described in detail in an illustrated, four-page brochure by Diaphragm Industries, Inc. Long stroke, rolling, preconvoluted, and molded-convolution diaphragms for either static or dynamic applications in aircraft and industrial use are discussed in technical terms.

Information about facilities for design and manufacture of complete diaphragm assemblies and actuators is also included in the brochure. —K-49

Gage Valves

Two four-page catalogs, Data Units No. 397 and No. 398 of Jerguson Gage and Valve Co., illustrate and describe the features, styles, sizes, and construction details of Jerguson union bonnet and screwed bonnet liquid-level gage valves which assure safe, dependable leak-tight service. Included are roughing drawings and detailed tables of standard and optional features. —K-50

Paint Systems

The Glidden Co. announces in a four-page brochure its line of Vinyl-Cote for chemical and corrosion-resistant paint systems for refineries, chemical plants, railroad rolling stock, ship bottoms, marine installations, water tank interiors and general industry. —K-51

Window Units for Liquids

Three types of versatile new window units, manufactured by Bijur Lubricating Corp., are described in four-page Bulletin 8-E: (*a*) Level-type window unit, for immediate visual check of liquid levels; (*b*) standard-type window unit, primarily used to observe level, condition, or flow of reservoir-kept liquids; and (*c*) open-type window unit, for observation of internal machinery parts, observing or checking liquid flow, and similar uses.

Typical applications, diagrams, and part numbers and sizes are given, as well as installation data. —K-52

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
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Steam Converters

Dunham-Bush, Inc. announces the publication of File No. 1460 describing its new line of SC steam converters for heating radiation water with steam. The catalog points that Dunham-Bush SC steam Converters offer definite advantages in many types of applications such as large installations when zoning is desirable and steam as the source of heat for the zone may simplify the piping design and reduce the design work required for exclusive use of water. The converters are commonly used for providing heating water for office space in industrial buildings, either in adding this space or at time of initial construction. The catalog includes specifications, operation data, leaving-water temperature tables from 170 through 230 deg F, piping installation diagram and waterside pressure-drop curves. —K-53

Numerical Control

The Bendix Industrial Controls Section has published a general catalog on the Bendix line of numerical control systems. This 16-page brochure, designated Catalog No. 308, covers the new DynaPath-20 series contouring controls, the DynaPoint-20 series and Ferranti positioning control systems. The unique Bendix-distributed Ferranti coordinate measuring machine is also presented, along with numerical control-system accessories and a run-down on Bendix contract services. Complete specification information is given for all units, as well as features and application data. —K-54

Wire and Cable

Silicone rubber is one of the most versatile wire and cable insulating materials available. A four-page illustrated bulletin is available which describes and provides data on the various kinds of silicon-insulated cable manufactured by the Boston Insulated Wire and Cable Co.

Entitled "Single and Multi-Conductor Cable with Silicone Rubber," the bulletin features power and lighting cable, hook-up wire, ignition cable, as well as an impressive list of conductor cable for shipboard, missiles, and nuclear power purposes. The cables described are made with General Electric silicone-rubber compounds and represent the latest in silicone technology. —K-55

Depth-Gage Handle

A two-page bulletin, No. 771, describing and illustrating its "Universal Adjustable Depth Gage Handle" is now being offered by Heli-Coil Corp. The device permits precise measurement of both the size and depth of all drilled or tapped holes. The bulletin contains complete discriptions of the various applications of the new depth gage handle, plus step-by-step operating instructions, complemented by illustrations. —K-56

Don't take chances on couplings

CHECK PUBLISHED MISALIGNMENT RATINGS BEFORE YOU BUY

Since misalignment is the basic problem that shaft couplings are designed to solve you'll find a published conservative misalignment rating (along with load capacity rating) for every Fast's Coupling. Compare it with the misalignment rating of any other coupling you are considering. One further advantage of Fast's Couplings' misalignment ratings: You save money on installation because, knowing the ratings, you don't have to line up driving and driven elements with pinpoint accuracy. It's one more important reason why Fast's Couplings are the choice of more equipment manufacturers than any other gear-type coupling. KOPPERS COMPANY, INC., 506 Scott Street, Baltimore 3, Md.

KOPPERS

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Tempering Units

Bulletin D-61, entitled "Controlled Atmosphere Tempering Units," has been published by Ipsen Industries, Inc., manufacturer of industrial heat-treating furnaces and related equipment.

The bulletin describes furnaces used for atmosphere tempering, annealing, and stress-relieving. The Ipsen DFC-4-600 tempering furnace is illustrated, and a cross-section diagram explains the details of the DU-4-600 atmosphere tempering unit. The latter includes an insulated quench tank in addition to the two-zone atmosphere cooling chamber. The temperature range of these units is 400 to 1500 F. —K-57

Engineers' Scales

V. & E. Mfg. Co., manufacturer of drafting equipment, has released a bulletin on "Architects and Engineers Scales," the latest in a series of entirely new catalogs and bulletins. Construction features, classifications of scales, and size ranges are described in Catalog No. 60-AE. —K-58

Mixing Valve

Aerodyne Controls Corp. announces data Bulletin No. 8 describing its motor-operated mixing valve. Mixing valves in the 21300 series feature speed of response and reliability as two main operating characteristics. Flow is controlled from the hot and cold inlet ports to a common outlet by a segment of a cylinder which rotates on bearings. Performance specifications and diagrams are included. —K-59

Revolving Tables

Swift Ohio Corp. in Bulletin No. RT-1100 announces its line of revolving indexing tables. Diagrams and tables giving information and specifications are included. Bulletins are also available describing tables equipped with numerical positioning controls. These tables are for use with radial drills, and horizontal and vertical drilling machines. —K-60

Locknut Installation

An 18-page Design Manual No. 6101 of Elastic Stop Nut Corp. of America includes 12 tables listing specific recommended installation torque values for thin and standard height UNC and UNF hex type elastic stop nuts. It discusses factors to be considered in selecting a tightening torque; also the effects of the use of lubricants. Additional data include tables of tensile-stress areas and tables of bolt strengths. —K-61

Jet Compressors

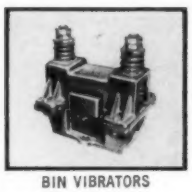
Schutte and Koerting Co. has released a new bulletin on its line of jet compressors, including fixed-nozzle, manually controlled spindle, and automatically controlled spindle types. The bulletin 4F, details construction, operation and application information. It also includes a nomograph to determine the possible weight ratio of secondary gas to primary gas and a second nomograph to determine the compressor size.

SK jet compressors use a high-pressure gas to circulate, boost low pressure and to mix, transfer, and compress gases. —K-62

SYNTRON

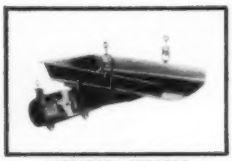
VIBRATORY

Materials Handling Equipment



BIN VIBRATORS

Syntron for more than 35 years the leader in vibratory materials handling equipment for all types of industry. Designers and manufacturers of a complete line of equipment that solves many production problems. Syntron equipment can be used as components to other devices. Whatever your current plans, it will pay you to contact your nearest Syntron Representative. He will give you reliable and unbiased advice as to the type and size of equipment for your particular need.



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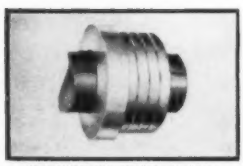

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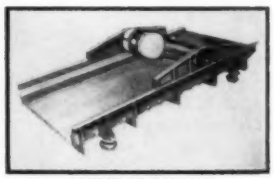

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Pumps

John Bean Div. of Food Machinery and Chemical Corp. describes its outside packed Triplex pumps for high-pressure pumping in Bulletin L-1484. These pumps are used with great dependability for handling industrial fluids such as caustic solutions, corrosive chemicals, chemicals, petroleum products, and many others. —K–63

Compressed Air Line Units

Hannifin Co. in Bulletin 0400-B1 announces a line of compressed-air preparation units including filters, regulators, lubricators, and "combos." This bulletin gives specifications, diagrams, and tables in an easy to read manner. —K–64

Glassed-Metal Pipe

A 16-page bulletin is available which describes glassed-metal pipe, valves, and fittings manufactured by Pfaudler Co., Div. of Pfaudler Permutit Inc.

The bulletin presents a short introductory paragraph on the need for glassed-metal pipe and accessories as a vital link in installations that require resistance to corrosion or contamination of product. Separate sections are devoted to Standard Glasteel pipe, non-adherence Glasteel pipe, expansion joints, F-C (field cut) Glasteel pipe, Glassed ductile iron fittings, sight boxes, glassed outlet valves, pop safety valves, spray-rinse valves, and other standard items. —K–65

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Acid Cleaner

Hagan powdered acid cleaner for use in cleaning scale deposits from boilers, heat exchangers, water lines, pumps and other equipment is the subject of a new bulletin, HSP-940, issued by Hagan Chemicals & Controls, Inc.

Hagan acid cleaner is a free-flowing mixture of a solid acid, corrosion inhibitor and antifoam. The active inhibitor makes the cleaner safe for use in systems containing iron, steel, copper, copper alloys, brass and aluminum. It is easy to handle, and there is no danger of fire, toxic fumes or explosion. No special storage is required. —K–66

Side Bow Chain

Publication of a four-page bulletin, No. 603P, describing its Rex Side Bow Roller Chain for conveyer curves, has been announced by the roller chain div., Chain Belt Co. These chains are adapted to curved applications on such equipment as bottling, packaging, canning, and baking conveyers.

Available with a variety of attachments, Rex side bow chains are designed for maximum service under abnormal conditions. Other uses for them, however, are practically unlimited. They allow new cost-cutting freedom in conveyer layouts throughout industry since they can be simply curved around, above or below obstructions. —K–67

Oil-Tight Switch

A four-page bulletin describing the new Joy Flexitite all-rubber push-button station for oil-tight and duty service has been published by Joy Mfg. Co., Electrical Products Div.

The recently introduced switch is described as "the first oil-tight switch at less than heavy-duty prices." It is recommended for all two-button applications: Start-stop, on-off, forward-reverse, up-down, and so on. It is said to be corrosion proof, dust and moisture proof, electrically safe, easy to mount on any standard FS or FD box, and maintenance free. The switch meets NEMA type 1, 3, 4, 5, and 12 enclosure requirements. —K–68

Blast Cleaning Barrels

Exclusive features found in Pangborn Corp. standard-duty line of blast cleaning barrels is described in Bulletin No. 706. This 16-page booklet is directed to manufacturers of castings, forgings, weldments, plastics, and to auto-parts reconditioners. It is well illustrated with diagrams and photographs, and contains brief specifications and dimensions of each of the five sizes ranging in capacity from $1\frac{1}{2}$ to 18 cu ft.

A number of case histories are outlined to show how many companies have realized substantial profits by using either standard or automated Rotoblast units. —K–69

KEEP INFORMED

BUSINESS NOTES
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Fasteners

New Aerospace Catalog No. 960 of Elastic Stop Nut Corp. of America is a 64-page manual which focuses attention on reduced dimension, lightweight types of selflocking fasteners. Its purpose is to provide the design engineer with a concentrated package of nut shapes covering complete lines of miniature hex, anchor and clinch types which experience has shown to be useful in the assembly of units intended for avionic and electronic end use. Special emphasis is placed on clinch types of elastic stop nuts including a new "floating" type of blind fastener and two new right-angle bracket nuts suitable for panel and cover assemblies. Complete instructions on "how to install" clinch nuts are presented; available tools and production methods are illustrated. —K-70

Optical Scanner

Farrington Mfg. Co. describes its optical scanner Model 1P5P in a four-page brochure.

This electronic scanner performs the function of reading a specific type style, upper and lower case alphabetic characters, common punctuation marks, and numeric characters. Model 1P5P has ability either to read full pages of typewritten information, single or double-spaced, or to scan entire pages in search of particular information, further translating it into a punched paper tape code. Whether the 5-level or the 6-level code is used, the page reader scans and punches 240 characters per second, automatically feeding from page to page.

Among the many potential uses, the 1P5P offers automated systems in such areas as communications transmission, typesetting, data reduction, scientific literature abstraction, catalog indexing and language translation. —K-71

Silicones

A new and comprehensive booklet on silicones containing the most recent and advanced information on these important man-made chemicals has just been issued by Silicones Div. of Union Carbide Corp. as an aid to engineers and technical personnel.

Graphically illustrated with photographs, charts and graphs, the booklet goes into detail about what silicones are, describes their manifold uses for consumer and industrial products, and suggests ways in which they can be adapted to a host of new applications by the design engineer or product development manager. —K-72

Centrifugal Pumps

The Deming Co., has announced a new, low-cost centrifugal-pump line. Bulletin 3913 describes Deming's new double ball-bearing, end-suction, centrifugal pump. Descriptions, photographs, performance tables, and dimension prints are all shown for Sizes 1 through 3 in. —K-73

More equipment manufacturers choose Fast's Couplings than any other gear-type coupling

Leaving other claims aside, the thing that counts in couplings is customer confidence—and industrial equipment manufacturers have made Fast's their overwhelming choice. The Fast's line is more diversified, too—in a complete range of sizes and types for shafts, from ½" to 32" and larger.

Every Fast's Coupling brings you superb engineering only the original gear-type coupling can deliver. Smooth-running units that are designed to outlast the machines they connect. Rapid service from experienced field engineers backed by outstanding stock facilities. Write today for full details on couplings to suit your needs to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 506 Scott St., Baltimore 3, Maryland.

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Cranes and Carriers

A booklet titled "Engineering and Application Data," No. 2008Q, has been completed by the Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co. Up-to-date information is provided for those interested in overhead materials handling.

Various types of carriers, cranes, tractors, track switches, grabs, electrification are described. Detailed studies of track design, peening and stresses are given. A large number of photographs of a wide variety of Cleveland Tramrail installations are also featured. —K-74

Packaged Air Compressors

New illustrated Bulletin 203, just issued by Clark Bros. Co., Div. of Dresser Industries, Inc. introduces the Clark C-Line of packaged air compressors for industrial applications. The line includes four models rated at 25, 50, 75, and 100 hp, respectively.

Fully described and illustrated are all important features including compact, W-type design, two-stage compression, air cooling, compressor cylinders, auto-plate valves, heavy duty crankcase and running gear, fin and tube type intercoolers, force feed lubrication and controls for continuous or intermittent duty. Longitudinal and transverse cross sections with callouts highlight important construction features. Brochure includes a complete list of dimensions, weights and specifications for the units which can be furnished with or without drive. —K-75

Self-Locking Blind Nut

A new solution to the problem of blind fastening is offered in a product bulletin published by Standard Pressed Steel Company. It covers the SPS Davis press nut. The literature reviews the principle of operation of the unique one-piece, flush-mounting nut; suggests possible applications, principally in airframe, missile, and comparable sheet-metal applications; and details general specification data.

A simple and economical means of attaching tapped holes to thin-sectioned assemblies, the Davis press nut has a tensile strength of 125,000 psi and is designed for use with longer thread length NAS shear bolts, including NAS Series 1303, 2803, 2903, and 3003. —K-76

Single-Roll Crushers

The Pennsylvania Crusher Div. of Bath Iron Works, has published a 12-page bulletin describing their new Atlas single-roll crushers. This bulletin is the first formal information available on the new Atlas crushers introduced late last year for primary crushing of soft gypsum, shale, slate, coal, fire clay, soft limestone, chemicals and phosphate rock. The bulletin covers in detail the operation of the Atlas crusher and of the patented overload release that automatically resets the breaker plate for correct product size. To complete the information usually needed to evaluate a crusher, the Atlas Bulletin No. 2025 also includes construction specifications, capacity tables, and detailed dimensions. —K-77

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Crankshaft Lathes

Wickes Machine Tool Div. of the Wickes Corp. shows a complete line of crankshaft lathes in Brochure-261.

Center drive, single and double-spindle crankpin, double-end drive, ring-type crankshaft, automatic-transfer crankshaft, and universal crankshaft lathes are illustrated and described. —K-78

Tolerance Rings

An illustrated, four-page brochure of Roller Bearing Co. of America announces the Star Tolerance ring, a corrugated open ring made of hardened steel. The ring serves as a wedging shim between a shaft and its mating part, or a housing and its related part.

Advantages claimed for the tolerance ring are that it provides for self-aligning, shock-absorbing, easy assembly and frequent disassembly, variable adjustment; eliminates effect of variations of temperature, keys, keyways; results in less machining, less damage in assembly, less scrap, less noise, less vibration, less expense. —K-79

Valves

The Ohio Injector Co. Diamond Anniversary Catalog Digest CD-2 shows a line of bronze, iron, cast steel, forged steel valves and includes miscellaneous accessories. Valve dimension charts and illustrations are included. —K-80

Quick-Disconnect Couplings

A quick reference to the basic valving and connection principles of quick-disconnect couplings is now available in a handy new eight-page booklet released recently by Aeroquip Corp. Prepared for use by design engineers in the aircraft and missiles industries, the booklet summarizes the advantages and limitations of specific valving and connection concepts.

The quick-disconnect couplings described in the booklet are used extensively on hydraulic systems, pneumatic installations, fuel lines, lube-oil systems, electronic cooling apparatus, corrosive fluids systems, and numerous types of gas-carrying lines. —K-81

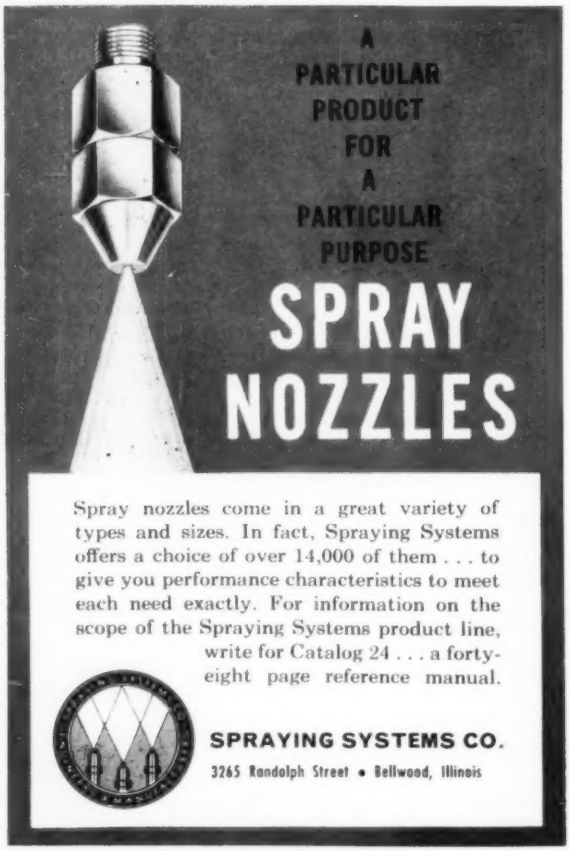
Metal Primer

A new concept in metal priming has been announced in a four-page brochure by The Glidden Co., called Rustmaster. This coating is designed for use in factories, on water towers, structural steel, storage tanks, fences, metal buildings, fire escapes, decorative metal, bridges, highway markers, and so on. It is said to be easy to apply, dries rapidly, and has outstanding adhesion and flexibility. —K-82

Computers

A four-page bulletin by Autonetics Industrial Products describes in detail major points of interest and specifications of Recomp III, a low-cost computer with floating point option.

This computer consists of only two basic assemblies; the computer module and the control module. Optional accessories such as the Flexowriter or the high-speed tape punch and tape reader input/output units may be added as required as needs increase. —K-83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Spray nozzles come in a great variety of types and sizes. In fact, Spraying Systems offers a choice of over 14,000 of them . . . to give you performance characteristics to meet each need exactly. For information on the scope of the Spraying Systems product line, write for Catalog 24 . . . a forty-eight page reference manual.
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THE INFLUENCE OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF METALS AND ALLOYS

E. M. Savitsky. Edited by Oleg D. Sherby. Much of the author's presentation is new and original and heretofore not available in English. Translated from the Russian. October. About $8.50

DISSERTATIONS IN PHYSICS

AN INDEXED BIBLIOGRAPHY OF ALL DOCTORAL THESES ACCEPTED BY AMERICAN UNIVERSITIES, 1861–1959. *Compiled by M. Lois Marckworth.* Part I is an alphabetical author listing with bibliographical information. Part II is a permutation subject index produced on the IBM 704 Computer. This is the first single source book for all American doctoral dissertations in physics. $17.50

PROCEEDINGS OF THE 1961 HEAT TRANSFER AND FLUID MECHANICS INSTITUTE

Edited by Raymond C. Binder, Robert L. Mannes, H. Y. Yang, and Melvin Epstein. The latest technical and scientific advances in thermo-dynamics, fluid mechanics, and related fields are presented in these papers to be given at the 1961 meetings of the Institute. $8.00

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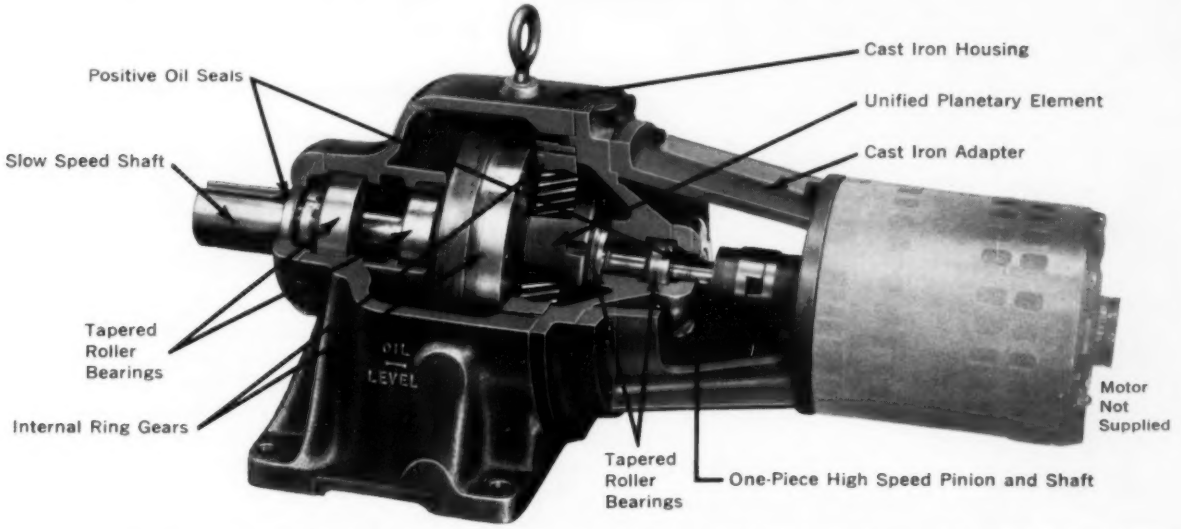
Engineering Data

WINSMITH SPEED REDUCERS

HORIZONTAL MOTORIZED DIFFERENTIAL SPEED REDUCERS



CAST IRON HOUSING—designed for high heat radiation. One-piece construction, close-grained gray iron for maximum strength and rigidity.

UNIFIED PLANETARY ELEMENT—integral primary and secondary planetary gears, mounted in a ductile iron cage—for even wear, equalized load, smooth operation. Hardened and ground, alloy steel gears carry entire power transmission load.

CAST IRON ADAPTER—permits use of any standard "C" flange motor. Flexible coupling (optional) connects motor to input shaft which can be driven in either direction.

INTERNAL RING GEARS—primary and secondary. Cut from alloy steel, heat treated for wear resistance.

ONE-PIECE HIGH SPEED PINION AND SHAFT—machined from alloy steel with teeth cut integral with the shaft. Hardened and accurately ground to close limits.

SLOW SPEED SHAFT—heat treated, precisely ground alloy steel. Low speed gear web of ductile iron.

TAPERED ROLLER BEARINGS—opposed pairs support the radial load, take thrust, ensure permanent alignment of both input and output shafts.

POSITIVE OIL SEALS—chevron type, keep oil in, dirt out. Oil and heat resistant, non-abrasive, low coefficient of friction.

AVAILABLE in any ratio from 1.1:1 to 50,000:1 without increasing the number of parts. Each model has a range of reduction ratios. Overall dimensions of individual models do not change regardless of ratio.

- *7 Models*
- *.12 to 81.51 H.P.*
- *Ratios 1.1:1 to 50,000:1*
- *Max. Output Torque 50 to 113,000 in. lbs.*

Series HM Horizontal Motorized Speed Reducers are a part of the Winsmith Planetary Differential Reducer line. They feature cut-tooth helical gears of 15° helix angle for smooth, positive power transmission—greater load carrying capacity—larger reduction ratios in smaller, more compact units—minimum wear and long service life. Winsmith Horizontal Motorized Differential Reducers are easy and convenient to install, require no bedplate, deliver more horsepower per pound of weight and cubic foot of space, and permit easier integration with the driven machine.

Write today for complete information or call your nearest Winsmith Representative listed in the Yellow Pages. He is a technically trained expert who is always ready to help you with any speed reducer problem. For both standard and special power transmission applications, you'll find it pays to standardize on Winsmith.

WINSMITH, INC.

203 Eaton Street, Springville, (Erie County), New York

MEMBER OF AGMA

• • • Winsmith Speed Reducers are made by American craftsmen to meet American design and production standards.

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it's NEW!

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A new development in compact, direct-acting solenoid valves—valves that sum up the best of all we learned in more than 90 years of valve and instrument making. Types, orifice sizes and electrical characteristics for a wide variety of media—air, water, petroleum products, coolant, oxygen, hydrogen acetylene. Most valves approved by Underwriter's Laboratories as a safety valve. Three-way types available.

Master-mite Solenoid Valves are *your* kind—sturdy, rugged, sure-footed under the toughest conditions including vibration. Valve bodies are machined from solid brass or 18-8 stainless steel bar stock. The strength is where it counts—in the valve body!

Operation of the Master-mite is positive but quiet. It seals bubble-tight at pressures up to 540 psi. All parts in contact with media are stainless steel. Operates equally well in any position.

Above all, Master-mite is a Marsh valve—a valve that combines instrument precision with the strength and stamina that distinguishes all Marsh products.

SPECIFICATIONS

Types
Conduit type (above) and grommet type (below). Two-, and three-way. Globe, bottom outlet, angle left, angle right.

Sizes
⅛" and ¼" NPT

Pressures
Vacuum through 540 psi

Orifice sizes
3/64", 1/16", 5/64", 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", ¼"

Voltages
Standard with 115 volts 50/60 cycle AC Coils, but also available in 6, 12, 24, 208, 230 and 460 Volts, 50/60 cycle coils.

Leads
Standard with 18" leads as shown, but other lengths available; also full range of connectors.

Body
Brass bar stock or 18-8 stainless. Moving parts all stainless.

Seat disc
Synthetic rubber

2 way valves
UL approved as a safety valve

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Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada.
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.
Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N.J.

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BONUS LIFE

BONUS PROTECTION

from the Boiler Capital of the World

THE TITUSVILLE WTP
FROM THE BOILER CAPITAL OF THE WORLD

• BONUS LIFE means longer life and less refractory maintenance made possible by Titusville's unique WTP design featuring *65% Black Surface Tube Area coverage on rear wall.*

Titusville's increased black surface tube area means less refractory maintenance through longer refractory life (less down-time for replacement) and a faster steamer.

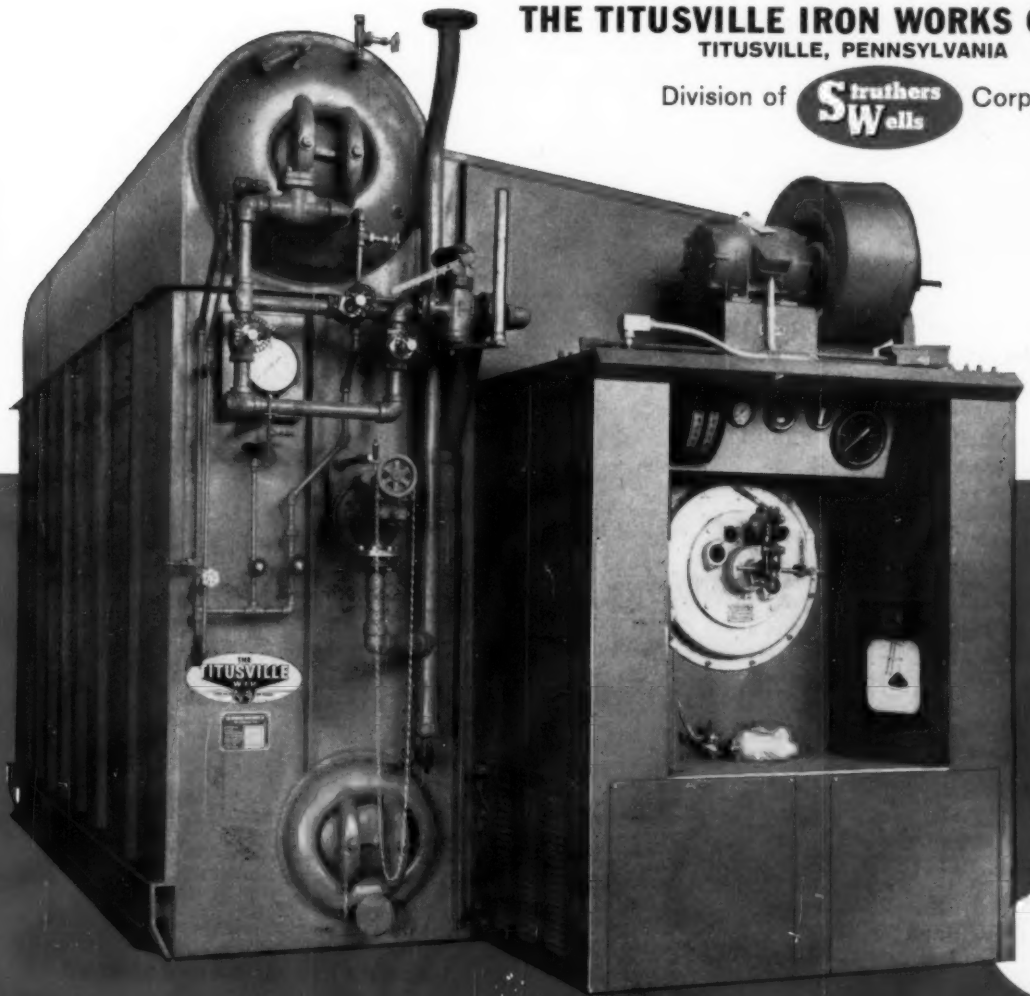
• BONUS PROTECTION provided by Titusville WTP's *double casing design* solves the corrosive product problem.

Most water tube steam generators operate intermittently. When dew point is approached at low fire condition, corrosive product can form quickly in single casing boilers.

Titusville WTP's double casing design (with insulation between) reduces temperature differential. Result: formation of corrosive product almost entirely eliminated for many times more casing life.

THE TITUSVILLE IRON WORKS COMPANY
TITUSVILLE, PENNSYLVANIA

Division of Struthers Wells Corporation



Specify Titusville WTP ... the industry's fastest selling boiler

Selected exclusive sales territories available

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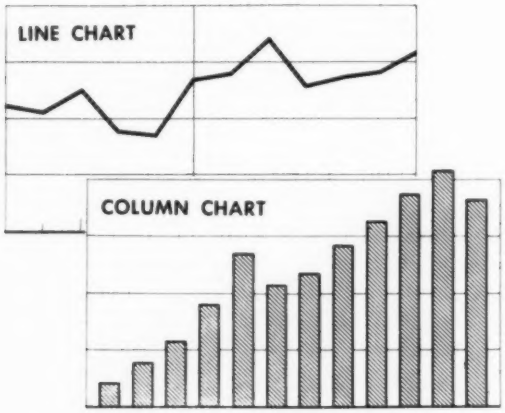
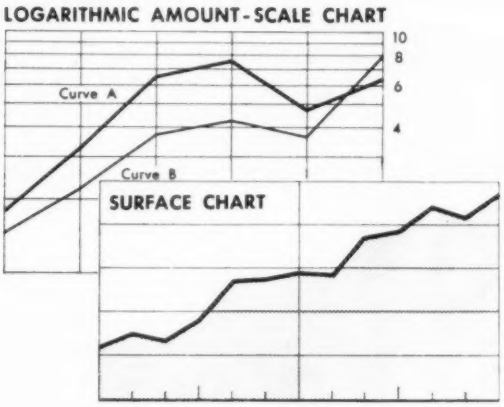
PRESENTING the best current practices on chart-making and preparing illustrations for publication and projection

If you are concerned with the preparation of charts that include "time" as one of the principal elements, you'll find detailed procedures that are easy to use and understand in—

Time Series Charts

(American Standard Y15.2-1960)





Covering line charts, surface charts, column charts, and logarithmic amount-scale charts this manual sets forth standard practices for:

- layout and design (size, proportion, composition)
- shape and ruling of the grid (framework)
- choice of scale and presentation of the data to scale
- design and use of the curves in the scale
- captioning the curves
- preparing and using titles, subtitles, and notes

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- makes feasible the use of a single drawing for either a slide or a printed illustration
- includes the latest easy-to-use information on drafting techniques
- illustrates the results possible with modern electric typewriters and lettering guides

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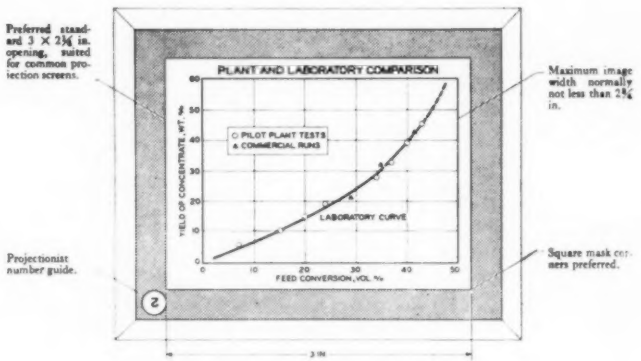
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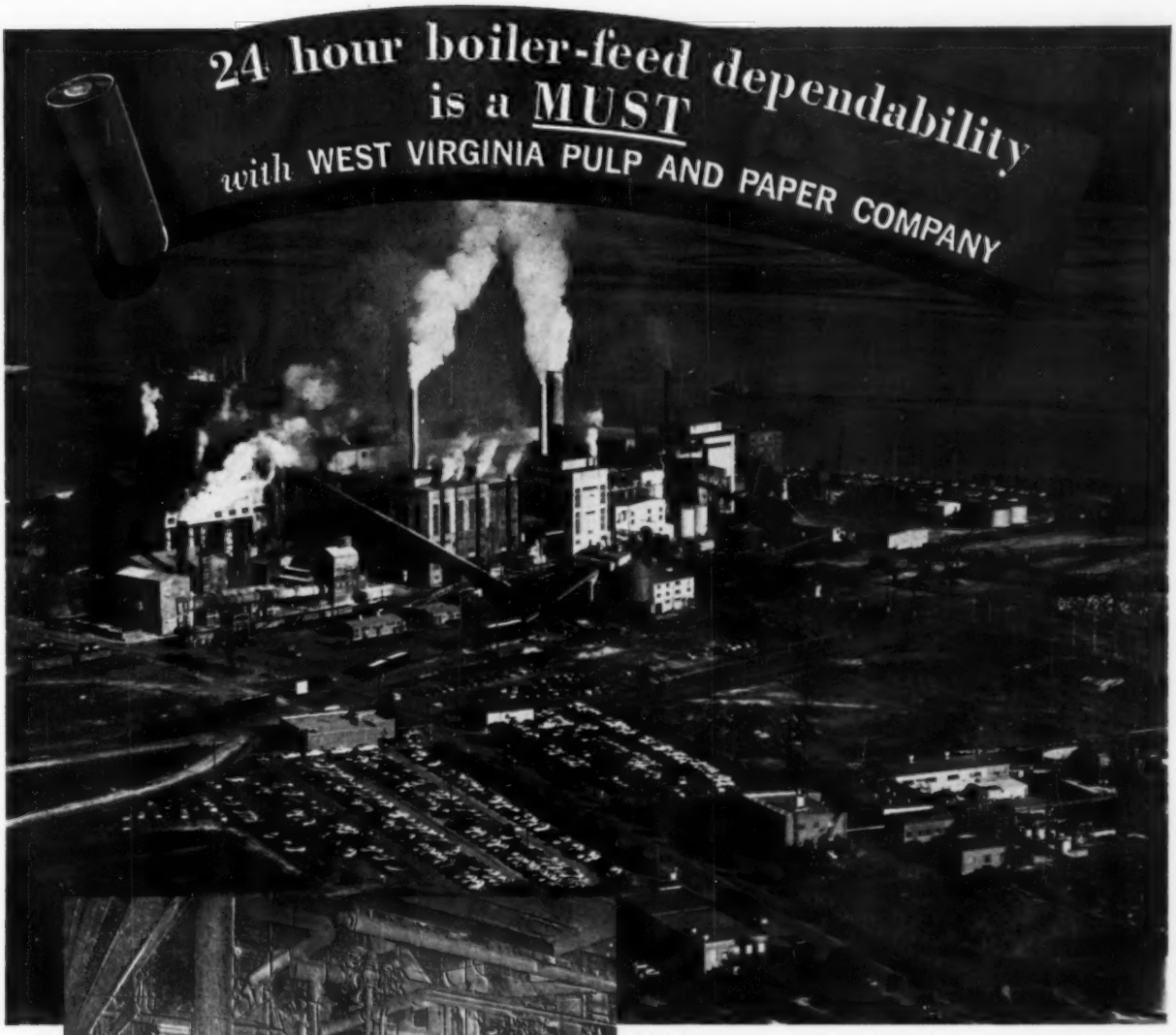

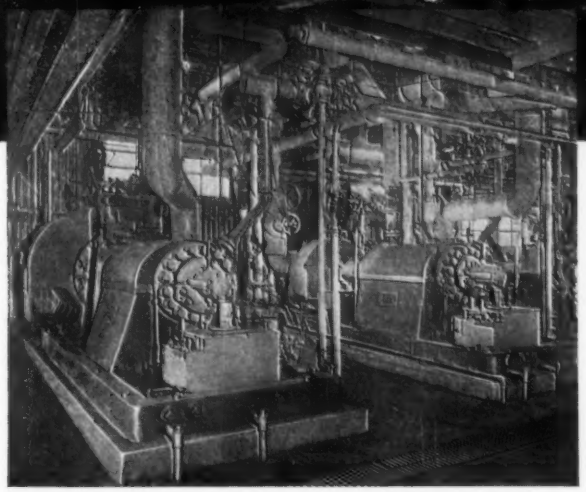

Pacific Type BFI pumps feed the latest boiler installation to help provide 1 million 620 thousand pounds of steam per hour required for 58,875 KVA power generation and plant process steam. A similar Pacific boiler feed installation is in 24-hour operation at the West Virginia Pulp and Paper Company plant at Luke, Maryland.

The Charleston, S.C. paper plant (illustrated above) is one of the largest producers of pulp and paper in the United States. The pulp mill processes 3 million 100 thousand pounds of unbleached sulphate pulp every 24 hours. The paper mill turns out 2 million 800 thousand pounds of linerboard, unbleached and extensible paper every 24 hours and several by-products.

Obviously, it takes a tremendous amount of power and steam to handle a job of this magnitude. The latest boiler installation at this plant is fed by three Pacific Type BFI 4", 10-stage pumps which are on the job, around-the-clock—*doing their part of the job.*

Pacific boiler feed pumps are second to none—in design, quality, performance, dependability, plus unparalleled parts and engineering service.

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Inc... A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA, U.S.A.

PACIFIC

CENTRIFUGAL PUMPS FOR PETROLEUM, CHEMICAL, UTILITY & GENERAL INDUSTRIES
OIL WELL PUMPS

DRESSER INDUSTRIES INC.

BF-31

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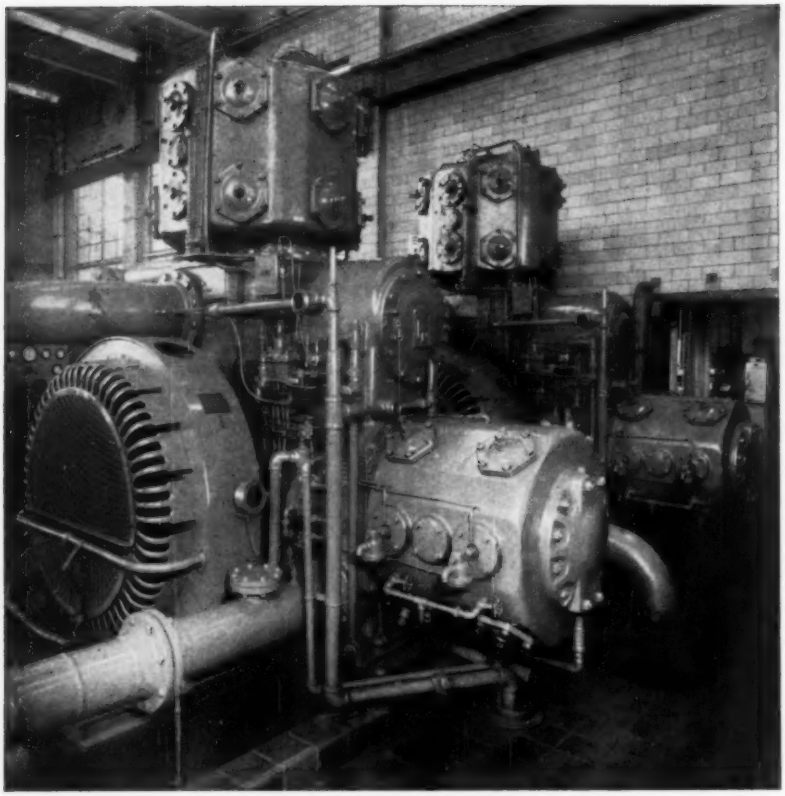

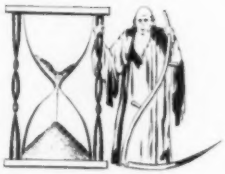

IN I-R COMPRESSORS,

TIME TELLS

THE DIFFERENCE

In these two XLE compressors, 21 Channel Valves have operated

45,482 HOURS

with no parts replaced!

The two Ingersoll-Rand XLE air compressors shown above are installed at a large midwestern automotive plant. They were started up in May, 1951, and at this writing have totalled 45,482 hours, mostly at 16 to 24 hours a day.

Of the 28 Channel Valves (14 per unit), 21 have operated full time with *no repairs,* merely being cleaned once a year. Each of the other seven valves had only one channel and spring replaced in all this time, during the scheduled inspection period. And all the valves are operating with their seat plates still on the first side—when the plates are turned over, their life will be doubled.*

The *extra value* that's built into every type of Ingersoll-Rand compressor pays off with *long-run economy*. Reduced maintenance and attention, over many years, mean long-range savings in the cost of air power. Ask your I-R representative for more information on the world's most complete line of compressors, from 1/2 to 7500 hp. Call him now.

***Only I-R compressors have Channel Valves**
Known for high efficiency, quiet operation and exceptional durability. Entirely different. Each valve is a combination of rigid stainless-steel channels and bowed leaf springs, with trapped-air spaces which cushion action, prevent impact.

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The World's Most Comprehensive Compressor Experience

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6	21	42	55	67	79	96	108	120	132	147	160
7	23	43	56	68	80	97	109	121	133	148	161
8	29	44	57	69	81A,B,C	98	110	122	134	149	162
9	30	45	58	70	82	99	111	123	135	150	163
10	31A	46	59	71	83	100	112	124	136	151	164
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K-2	K-13	K-24	K-35	K-46	K-57	K-68	K-79
K-3	K-14	K-25	K-36	K-47	K-58	K-69	K-80
K-4	K-15	K-26	K-37	K-48	K-59	K-70	K-81
K-5	K-16	K-27	K-38	K-49	K-60	K-71	K-82
K-6	K-17	K-28	K-39	K-50	K-61	K-72	K-83
K-7	K-18	K-29	K-40	K-51	K-62	K-73	
K-8	K-19	K-30	K-41	K-52	K-63	K-74	
K-9	K-20	K-31	K-42	K-53	K-64	K-75	
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K-11	K-22	K-33	K-44	K-55	K-66	K-77	

Code number identifies location of item in Keep Informed Section—beginning page 131

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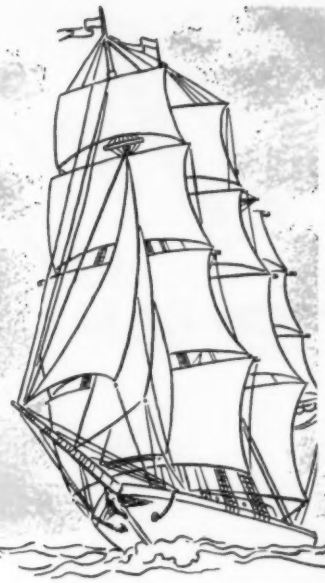
Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

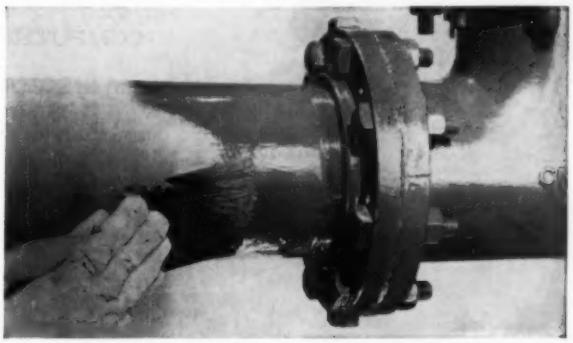
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



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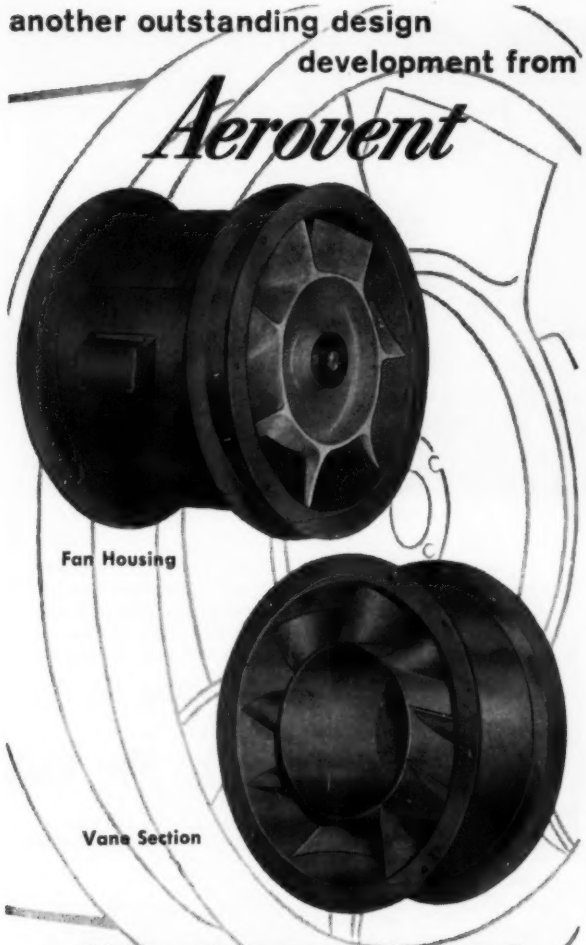

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with removable vane sections

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Qualified for Missile In-flight applications. Operates on 25-30 VDC. Available with ranges of 5 to 1,500 psi, differential, gage or absolute. Output, 0-5 VDC.

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PACE *engineering company*

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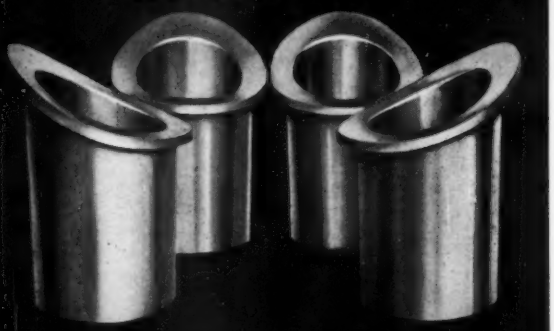

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NICE BALL BEARING CO.
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A 24-PAGE LIST OF ASME PUBLICATIONS

is included in the
1961 MECHANICAL CATALOG

Copies of this List are obtainable from
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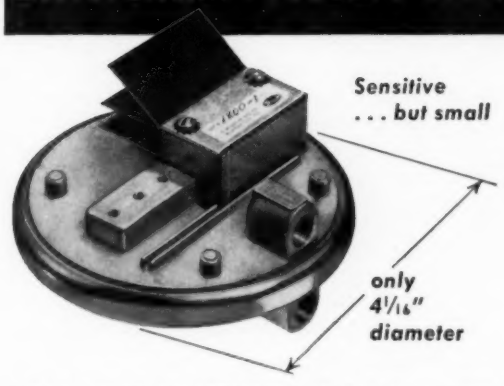

New Dwyer No. 1800 Series Switch is compact, low cost and highly sensitive to differential pressures in ranges from 0.15" to 80" water. Holds set point through various total pressures. Because of unusually small mass of moving parts, it is virtually unaffected by vibration. Use in any position. Pilot lights, explosion-proof housing, other optionals available. Request Bulletin E-40 for specs.

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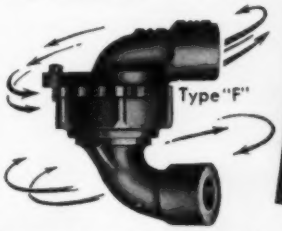

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through moving pipe lines

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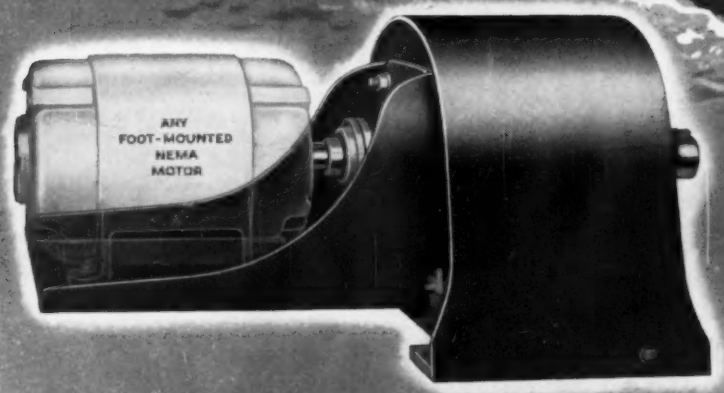

20,000 hp at 100 rpm

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THE FALK *ALL-STEEL*, ALL-MOTOR MOTOREDUCER
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SHAFT MOUNTED DRIVES
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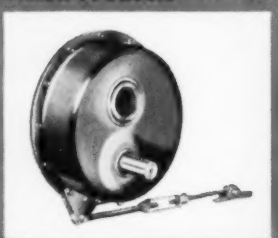

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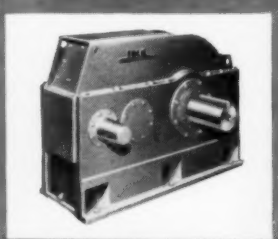

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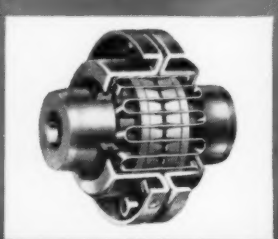

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The work involves research and analysis in many areas of fluid flow including material transport, turbulence, boundary layers, mixing, flow through porous webs, free and submerged jets, secondary motion and two-phase flow.

This position, located at our Research and Development Center, offers every opportunity for professional recognition and growth in the presence of stimulating associates, working conditions and recreational opportunities.

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B.S. in CE or ME. CE preferred. Minimum of 5 years' experience in Chemical Plant Design Engineering or related industrial experience. Position requires knowledge of structureal and concrete design for equipment supporting structures, piping and pressure vessel design. Must have ability to prepare drawings, bills of materials, and construction specifications, and be willing to do board work.

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2. We are a leading producer of flexible urethane foams for the furniture manufacturing industry.

   This unusual opportunity for a young engineer is due to our phenomenal growth in an industry that is expanding very rapidly.
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All inquiries in strict confidence.

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Box CA-7174 Care of
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ARMOUR RESEARCH FOUNDATION is a well-known independent research organization with a staff of over 600 engineers and scientists, which conducts a wide variety of research programs for industry and government. In this position you will have an opportunity to develop research areas of great appeal to you and your staff. Our environment is midway between academic and industrial.

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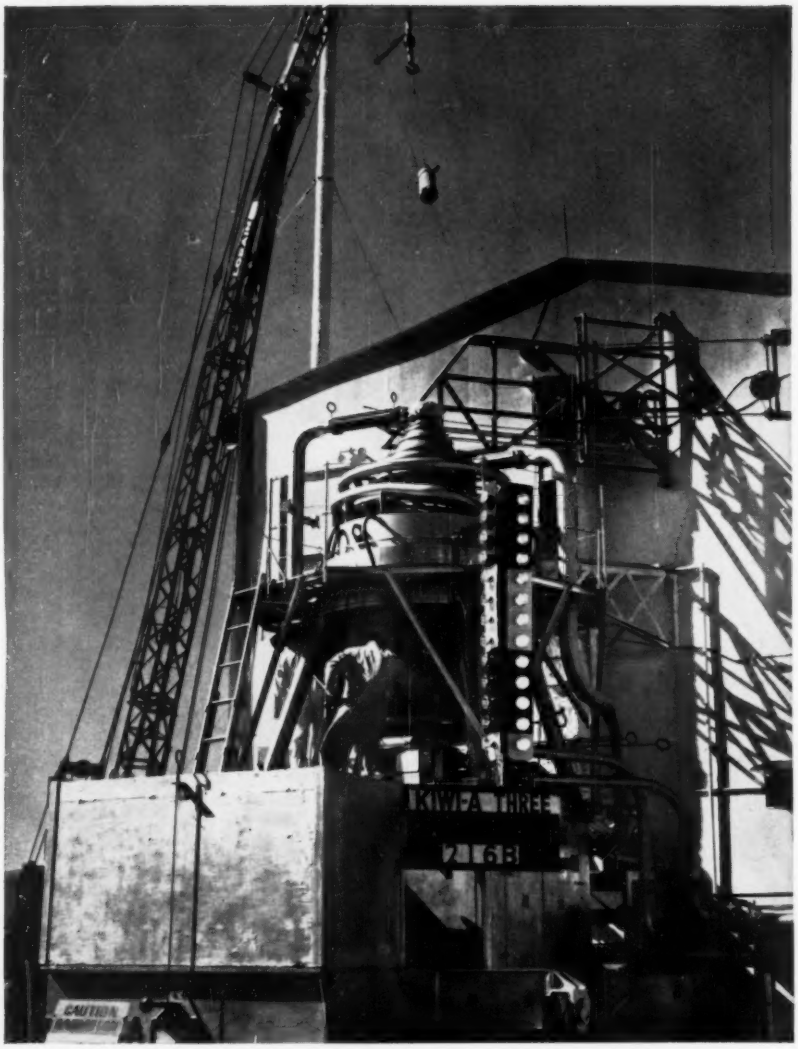

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Personnel Director, Division 61-56A

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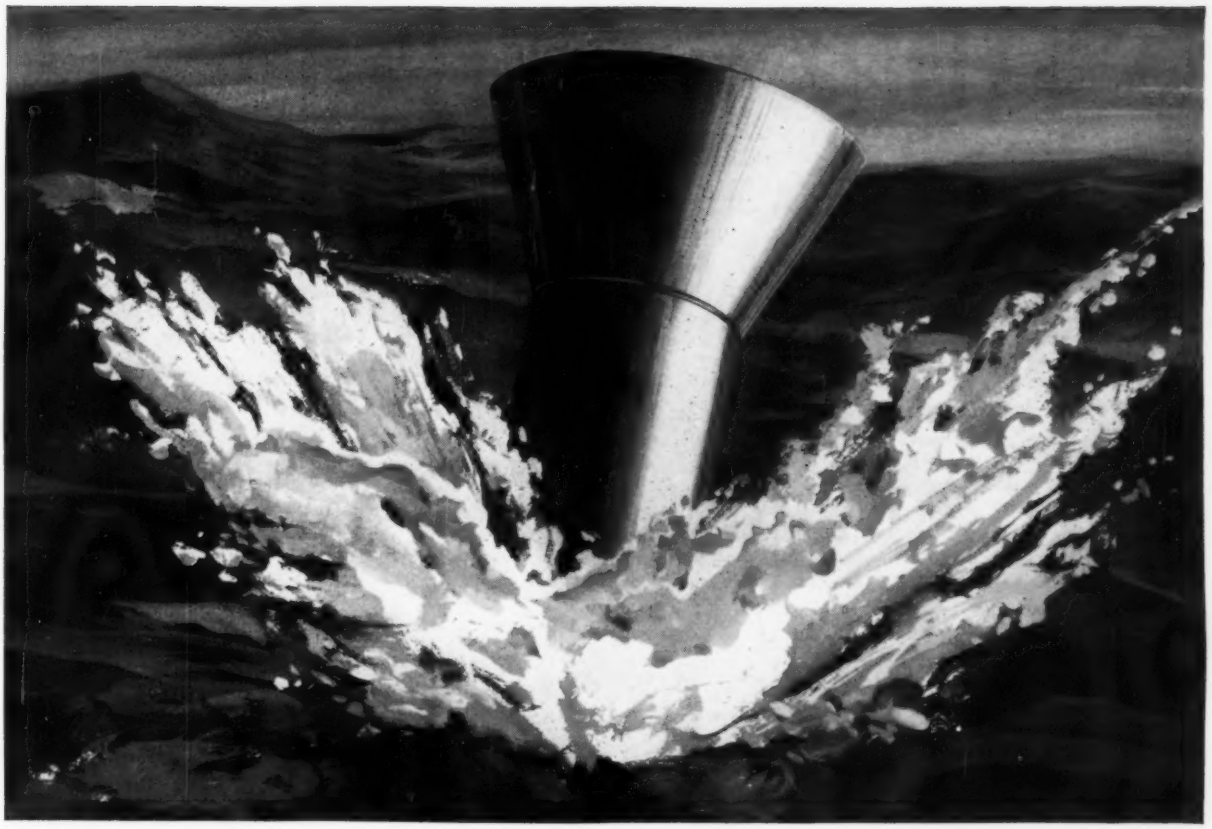

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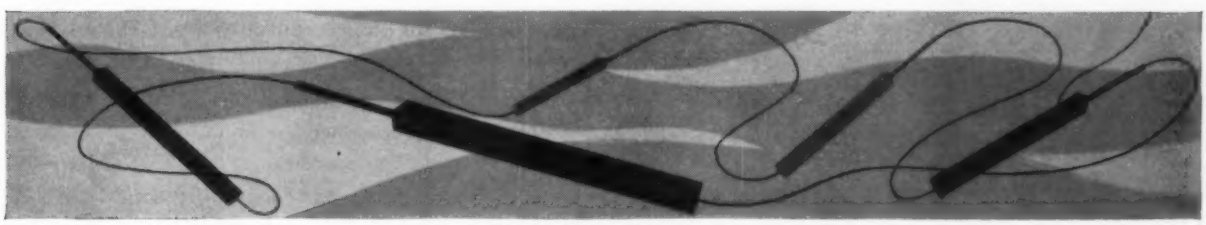

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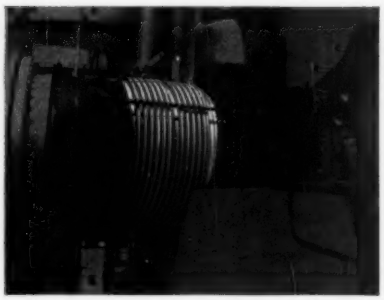

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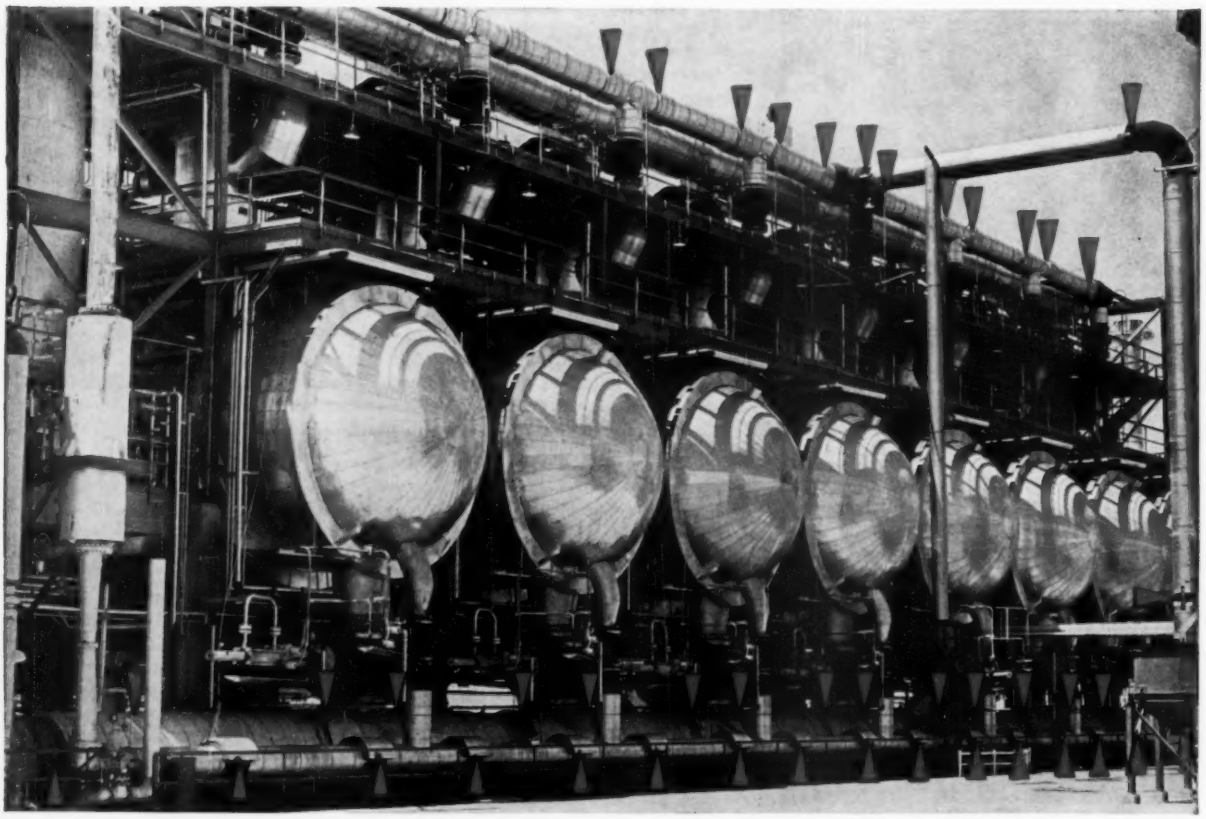

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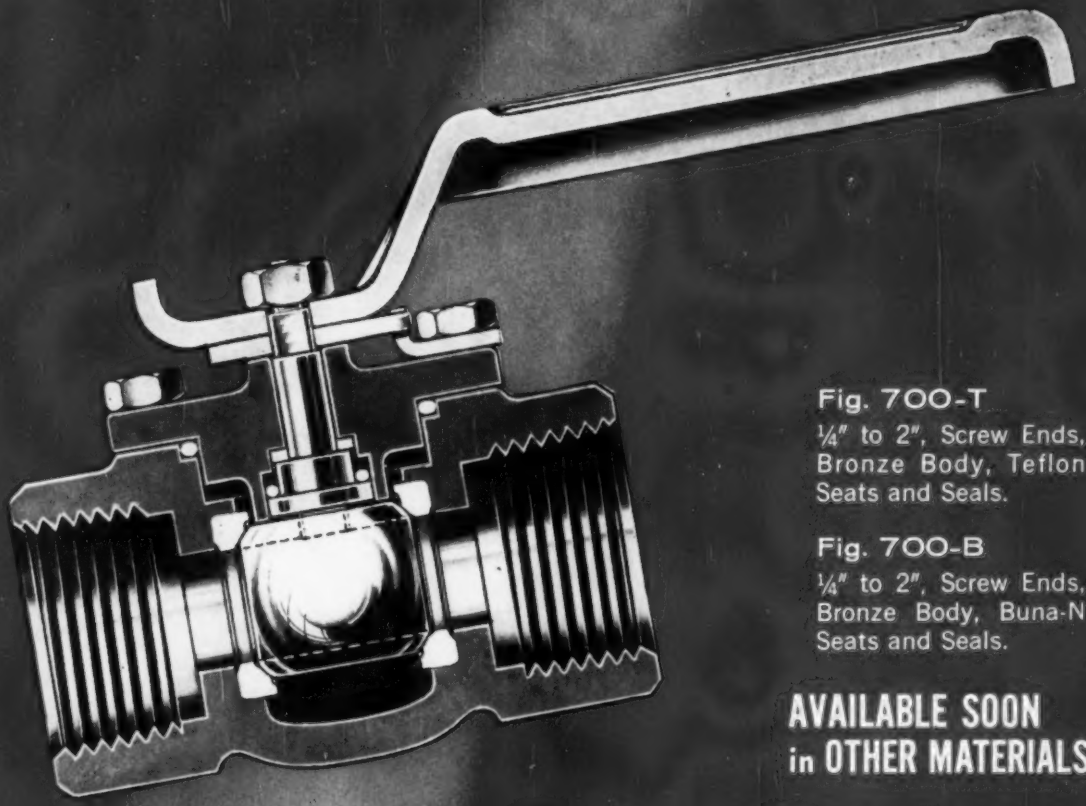

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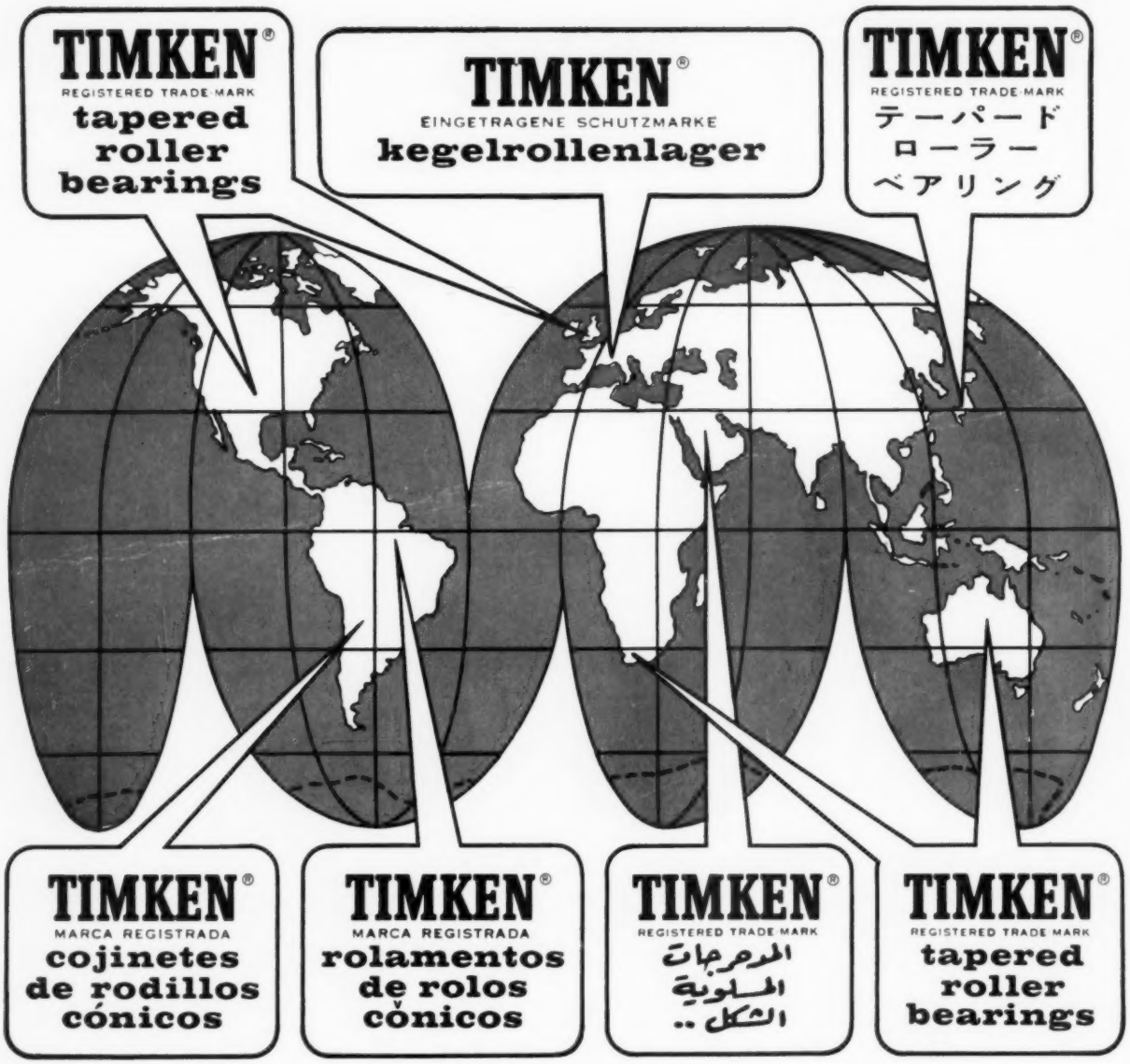

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